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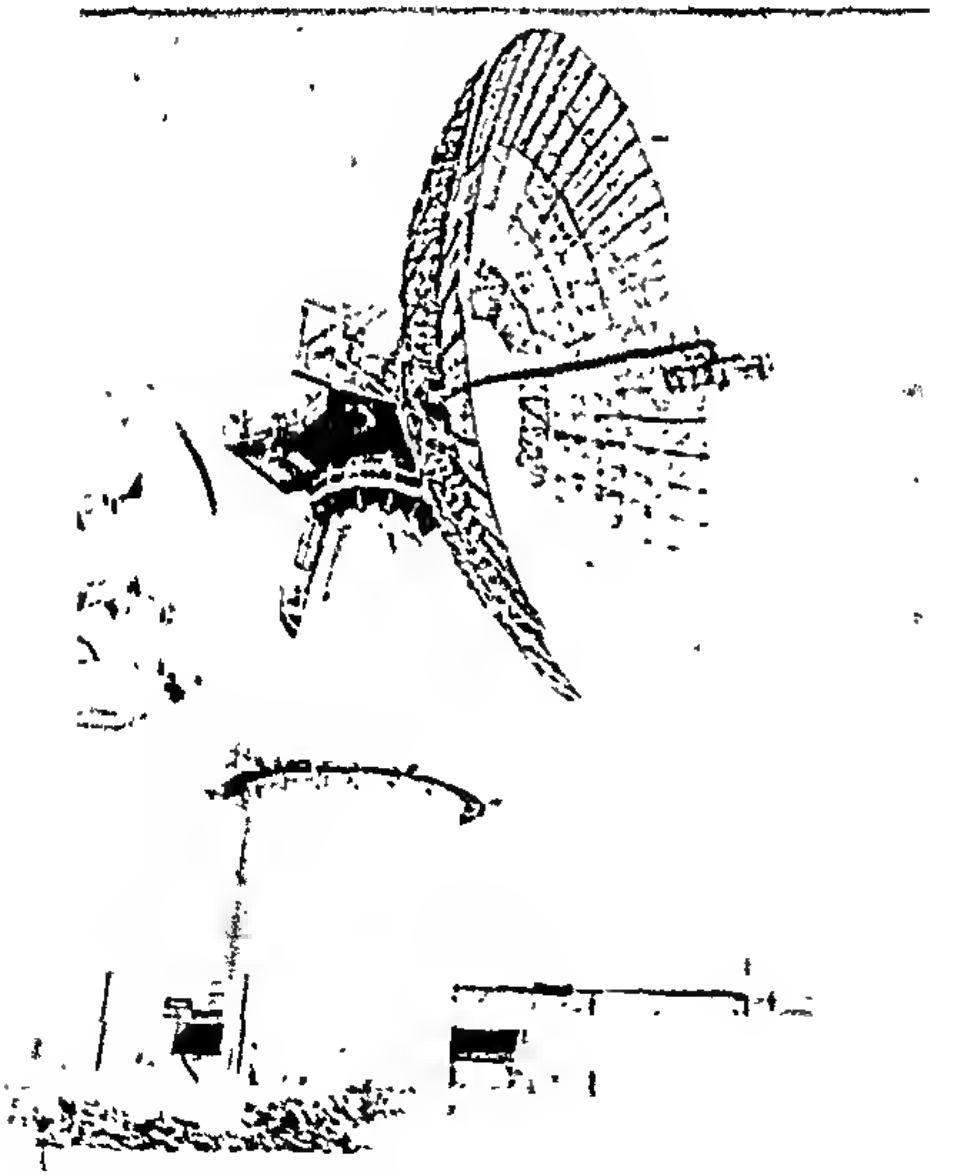
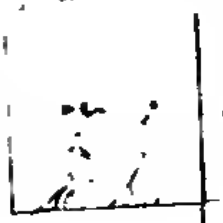
YOUNG PEOPLE'S ENCYCLOPEDIA



PHYSICS • CHEMISTRY
MATHEMATICS •

ALFRED B NOBEL
1833-1896 •
Invented dynamite,
started Nobel Prizes



HIPPOCRATES
460–370? B C •
"Father of Medicine"

MARIE CURIE
• 1867-1934
Discovered radium
and polonium

ENRICO FERMI
• 1901-1954
Produced first atomic pile and first
controlled nuclear chain reaction

THOMAS ALVA EDISON
1847-1931 •
Invented light bulb,
phonograph and mimeograph

64660
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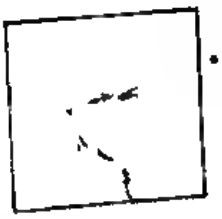
NICOLAUS COPERNICUS
• 1473-1543
First astronomer to say that Earth
goes around the sun



LUTHER BURBANK
• 1849-1926
Invented new
varieties of plants

EDWARD JENNER
1749-1823 •
Discovered smallpox vaccine

CHARLES DARWIN
1809-1882 •
Conceived the Theory of Evolution
through Natural Selection

WILLIAM HARVEY
• 1578-1657
Discovered the circulation
of the blood

GEORGE WASHINGTON CARVER
1864-1943 •
Experimented with
practical botany

SAMUEL F. B MORSE
• 1791-1872
Invented telegraph and Morse code

LOUIS PASTEUR
• 1822-1895
Invented pasteurization

GALILEO GALILEI
1564–1642 •
Discovered law of pendulum motion

CAROLUS LINNAEUS
• 1707–1778
- Classified the plant and animal kingdoms

SIGMUND FREUD
• 1856–1939
Started psychoanalysis

GREGOR JOHANN MENDEL
1822–1884 •
Discovered principles of heredity

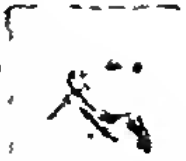
BARON ERNEST RUTHERFORD
1871–1937 •
Contributed to knowledge of radioactivity and atomic structure

GUGLIELMO MARCONI
• 1874–1937
Invented the wireless telegraph

LOUIS AGASSIZ
• 1807–1873
Investigated glacial motion and marine life

MICHAEL FARADAY
1791–1867 •
Discovered electromagnetic induction

SIR ISAAC NEWTON
• 1642–1727
Discovered laws of light, gravity, motion and color



ALBERT EINSTEIN
1879–1955 •
Conceived the Theory of Relativity

WILHELM KONRAD ROENTGEN
• 1845–1923
Discovered X-rays

JOSEPH LISTER
• 1827–1912
Started antiseptic surgery

ALEXANDER GRAHAM BELL
1847–1922 •
Invented the telephone

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Evanston, Illinois

VOLUME 14

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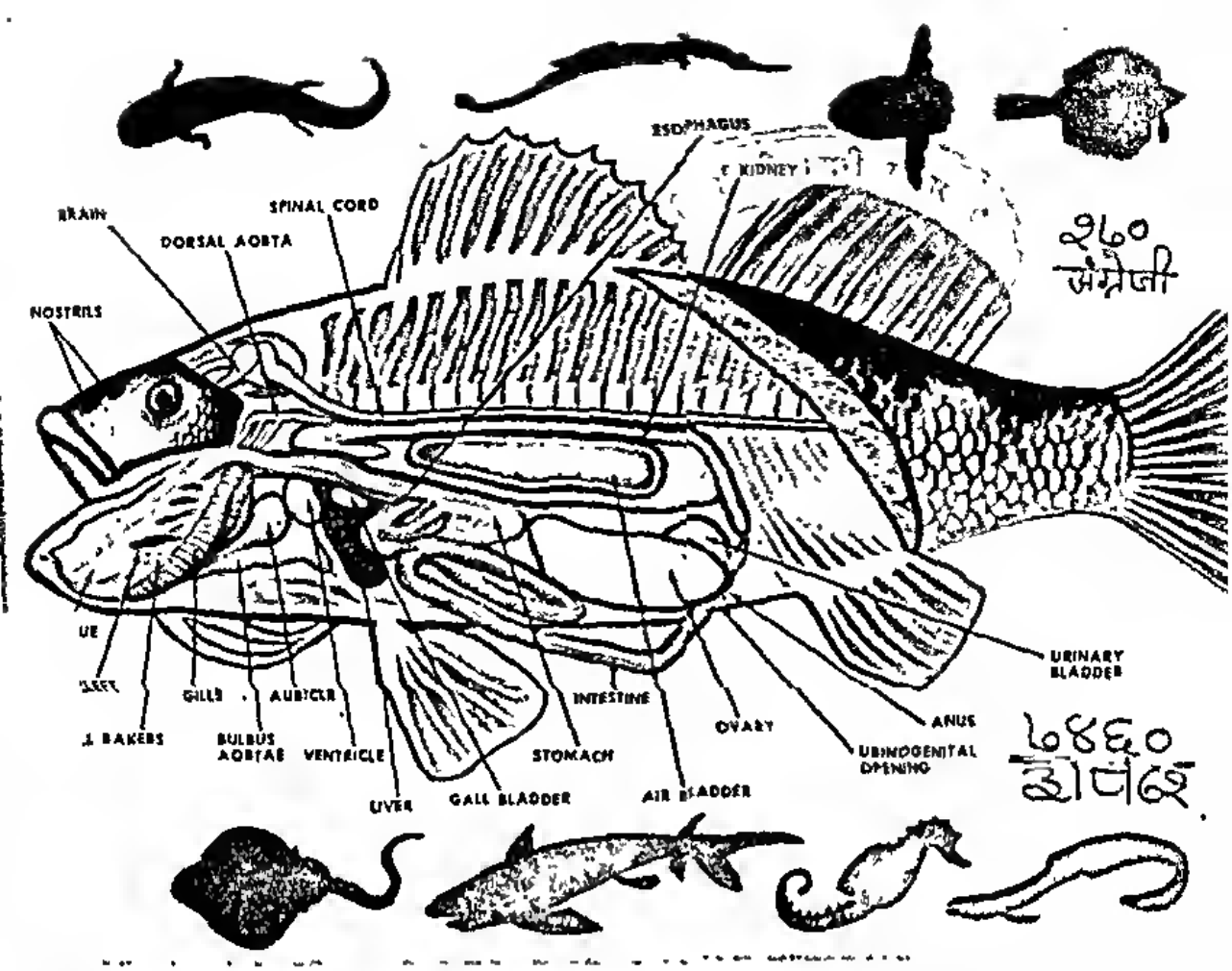


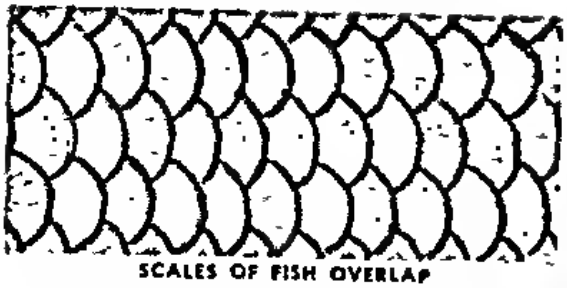
Pisces (Animal) (PIH-ceez) The scientific term for fish is *pisces*. Fish are found in almost every body of water. All fish are alike because they have backbones and need water in which to live. People use fish for food and find many ways to use the oils and skins. There are about 13,000 species. Not all animals people call "fish" belong to Phylum *Pisces*.

Fish appeared very early in the history of the earth. Scientists have found fossilized rock layers over four hundred million years old, from which it has been proved that fish first appeared in the Silurian Period and became numerous in the Age of Fishes, the Devonian Period that followed. Many millions of years passed before land animals appeared.

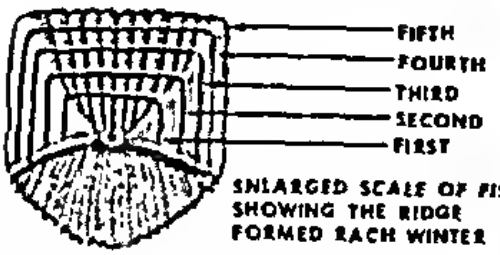
A true fish is cold-blooded, breathes through gills on each side, and depends almost entirely on water for life. It has a bony skeleton and a long-shaped body, narrowing at the tail. The fins at various parts of its body are used for steering, balancing, and moving it forward. An air bladder, often called *swim* bladder, helps it maintain balance to rise, descend, and adjust to water pressure. It has a heart which has two principal chambers: the *atrium* and *ventricle*. It reproduces by laying eggs.

Many variations, however, occur. LUNGFISH have limblike fins with air-breathing "lungs," sharks bring forth their babies alive; the sturgeon has a cartilaginous skeleton. Other examples are the catfish which has no scales, the climbing perch which actually climbs trees, and the FLYING FISH which rises from the water in gliding flight.

Fish have many interesting characteristics. Some mature in a few weeks; others may take up to twenty years. They may range from one-half inch in size to forty feet. Though the maximum age for a fish is generally one year, some live fifty years.



SCALES OF FISH OVERLAP



The age of scaly fish can be determined by the *ridges on the scales*

Stinging rays, spines in the fins or on the head, speed of movement, armor coating, hardscales with tiny needlelike spines, and powerful electric shocks are typical of some of the varied protective measures EVOLUTION has given fish.

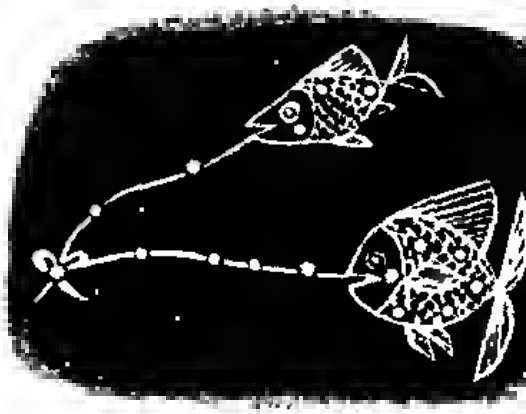
The most common food eaten by fish is plankton; a few eat large plants attached to rocks. Most of them devour worms, crabs, and shrimps, and some will attack oyster beds and shellfish. Many fish consume other smaller fish.

The fish have many enemies. Other fish and animals prey upon them In fresh water the bladderwort traps and digests baby fish. Insect larvae seek them out as well as squids and jellyfish. Seals, whales, and porpoises eat fish, as do marine birds

Fish are very useful. They provide an abundant food supply—nearly thirty billion pounds a year valued at seventy-five million dollars. The fishing industry is particularly important in countries like Norway and Japan and on a smaller scale in the U S A Fish also control the increase of harmful insects Their oils provide man with vitamins A and D, the swim bladder is used for the production of isinglass, and the skin provides shagreen, a type of leather.

There are two main groups of fish, those with cartilaginous skeletons (sharks-rays) and those with bony skeletons (perch, gar pike, seahorse) Of the five main groups of vertebrates, fish are the lowest. D E Z

SEE ALSO ANIMALS, CLASSIFICATION OF, FISH PLANTATION, SHARK



Pisces, the Fishes

Pisces (Constellation) (PIH-ceez Pisces is a group of stars that ancien people imagined to look like two fis in the sky. Pisces is an autumn con stellation. Its stars are not very bright The best time to look for Pisces is or a clear moonless night in autumn.

This constellation can be recognized by two streams of stars that come together in a V formation. The left side of the V ends in a small S shape. The right fish ends in a small circlet of faint stars. Ancient drawings of this zodiacal sign picture the two fish joined by ribbons on their tails.

According to the legend of Pisces, one day Venus and her son Cupid were walking on the banks of the Euphrates River. Typhon, a terrible giant, came along. Venus and Cupid jumped into the river and changed themselves into fish to escape Typhon Minerva placed the fish in the sky in memory of their fortunate escape.

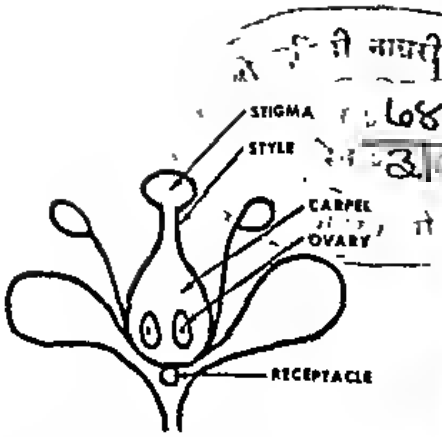
Pisces is the twelfth or last sign of the zodiac The sun is in this sign at the time of the vernal equinox On the first day of spring the sun's path crosses the celestial equator in Pisces. C. L. K.

SEE ALSO CONSTELLATION, ZODIAC

Pistachio see *Nuts*

Pistil *(PISS-till)* The pistil is the part of a flower that produces seeds. When complete it has three parts. These parts are called the *ovary*, the *style*, and the *stigma*.

The most important part of the flower is located at the very center Some flowers such as the buttercup and the raspberry have more than one pistil



The pistil (female part) of a flower

The typical pistil consists of an enlarged base, the ovary, within which the ovules are produced; a slender stalk (style) rising from the top of the ovary; and a somewhat enlarged tip (stigma) at the apex of the style. Without this pistil or female part of the flower, it would not be possible for the plant to reproduce. Pollen cells placed on the stigma eventually reach and fertilize the ovules in the ovary. V. V. N.

SEE ALSO: POLLINATION

Piston see Automobile, Engine

Pitch see Resonance, Sound

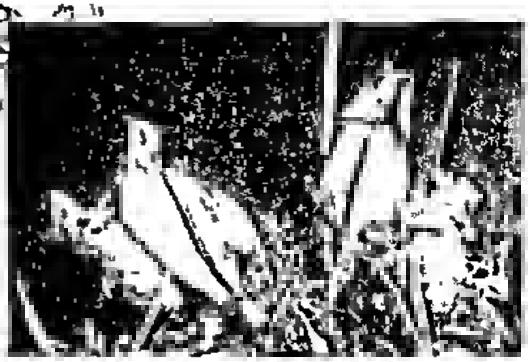
Pitchblende Pitchblende is the mineral which is the chief commercial source of URANIUM and RADIUM. It is brown or black, streaked with green, and dull in appearance except for freshly broken surfaces which have a faint luster and a greasy look.

In its pure form pitchblende is an oxide of uranium, formula UO_2; but it usually contains lead and small amounts of other elements, including radium. There are many varieties of pitchblende, each made up of a different combination of ELEMENTS.

Pitchblende is found in Czechoslovakia, England, Norway, and many other European countries and in several parts of the United States. It is nonmagnetic, brittle, and has a specific gravity varying from 6.4 to 10.6. E. R. B.

SEE ALSO: CURIE, MARIE AND PIERRE; RADIOACTIVE ELEMENTS

Pitchblende



These pitcher plants are closed, showing that they have recently dined

Pitcher plant The pitcher plant is an *insectivorous* flowering plant. This means that it is an insect-eating plant. There is a family of pitcher plants which are large and showy and grow in most marshy parts of the United States and Canada.

The pitcher plant has tubular, yellow-green leaves, brightly marked with deep red and purple veins which attract the insects. Fine hairs pointing downward grow at the mouth of the pitcher. The sweet smell of nectar at the rim of the leaf lures the insects into the leaves; then the hairs help to prevent the insect from crawling out where the walls are smooth and slippery. The insects fall to the bottom where there is water, and there they are trapped and digested by the plant. However, this plant still receives most of its food supply by PHOTOSYNTHESIS.

The globe-shaped, reddish-purple flower of the pitcher plant grows singly on a long, thin stem. Local names for the pitcher plant are: sidesaddle flower, huntsman's-cup, Indian dipper, trumpets, devil's boots, and Adam's pitcher. J. K. K.

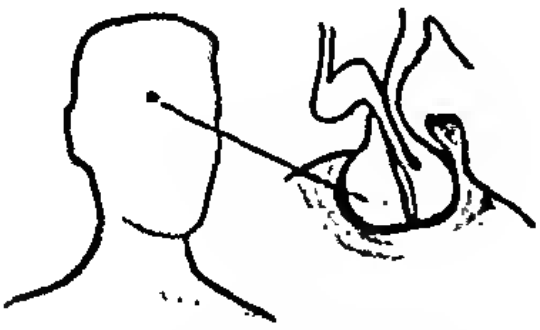
SEE ALSO: PLANTS, INSECTIVOROUS

Pith Pith is the tissue found in the center of young stems. The cell's walls are thin. Pith functions primarily as a food storage tissue.

Certain plants have pith strong enough to put to a special use. The pith of rushes, for example, was used for wicks in candles and lamps. M. R. L.

SEE ALSO: PLANT TISSUES

Pitot tube see Altimeter



Location of the pituitary gland

Pituitary gland (pih-TOO-ih-tairy) The pituitary is a gland found in higher animals. It is an endocrine gland that pours its secretion directly into the blood stream. It is located on the underside of the BRAIN, where it is well protected. The pituitary gland controls growth and many other glands and organs of the body.

The pituitary, or *hypophysis*, is a very small egg-shaped gland of about one centimeter in diameter and about 0.6 gram in weight. It is frequently referred to as the "master gland," but this is not entirely accurate since among the ductless glands of the body there is great interdependence—that is, they influence one another. No one gland is the key to the total system. Nonetheless the pituitary is of great importance because it affects the functioning of several organs in the body. Experimentation by means of injections of individual hormones produced by the gland, as well as through removal of portions of the gland, has given much information about it.

The pituitary may be divided into three main areas, the front part called the anterior lobe, a narrow middle area, the intermediate lobe, and the rear portion or posterior lobe.

The *anterior lobe* produces a number of hormones. Oversecretion of one of these brings about a condition known as *gigantism*. This, occurring in young people, causes an overdevelopment and lengthening of bones. The absence of this hormone can also bring about underdevelopment or *dwarfism*. For this reason it is called a *growth hormone*, though there are hormones produced by other glands which also affect growth.

Other hormones of the anterior lobe control the development and functioning of sexual organs. Another brings about milk production. Still others stimulate the THYROID gland (affecting growth patterns) the adrenal cortex, and the parathyroid glands.

The *posterior lobe* of the pituitary produces a hormone called *pituitrin*, a hormone which can be divided into several fractions, each affecting certain processes of the body. Pituitrin plays an important role in childbirth, causing contractions of muscles of the uterus and assisting in bringing about the birth process. Inadequate pituitrin may adversely affect the pancreas and bring about a condition of diabetes. D. J. I.

SEE ALSO: DIABETES, ENDOCRINE GLANDS, GIANT

Plain There are four great classes of land forms. They are plains, plateaus, hill country, and mountains. Plains rank first in total area and as the home of man.

Vast portions of the world's plains are sparsely populated, largely because of insufficient rainfall or too cold a climate. However, favorable soil, drainage, and climate enable some large plain areas to support moderate to dense population.

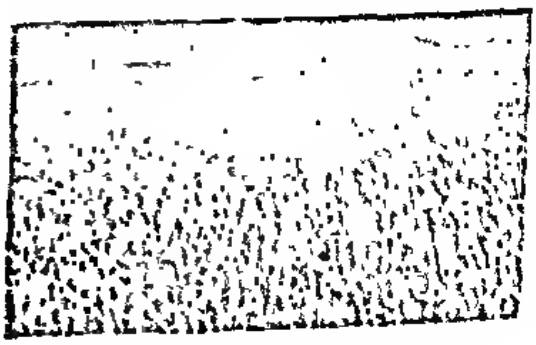
Plains constitute the great agricultural lands of the world. An example is the great American corn belt, an area that extends from central Kansas to eastern Ohio. As much as 70 to 80 per cent of this land area is plowed and planted in crops.

Plains are characterized by gentle slopes. The local relief, or the difference in elevation between the lowest points to the highest points within a limited area, is generally less than 500 feet. V. V. N.

SEE ALSO: RIVER

The great plains yield much wheat

Courtesy Society For Visual Education, Inc.



Planaria

Planaria (pluh-NAH-ree-uh) The planaria are fresh-water *flatworms*. One *planarian* is about one-half inch long, gray in color, and has a long, arrow-shaped body on which it slides over river-bed stones.

Planaria have two primitive sight organs or *eye-spots* and two touch-sensitive points at each side of the head. Strangely, the mouth and projectible tube-like pharynx are at the middle, *underside* of the body.

Flatworms are grouped in the phylum *Platyhelminthes*. They are in the most primitive phylum having true organ systems, these include a crude, network nervous system, a one-way digestive tract, and simple excretory tissue. The planarian's relatives include many species that are parasitic, such as the LIVER FLUKES. But there are also many free-living species in oceans and streams.

The planarian's movements result from two devices: its body is covered with microscopic *cilia* which beat in whip-like fashion and help propel it along surfaces; also the *muscle cells* of its flat underside help it slide.

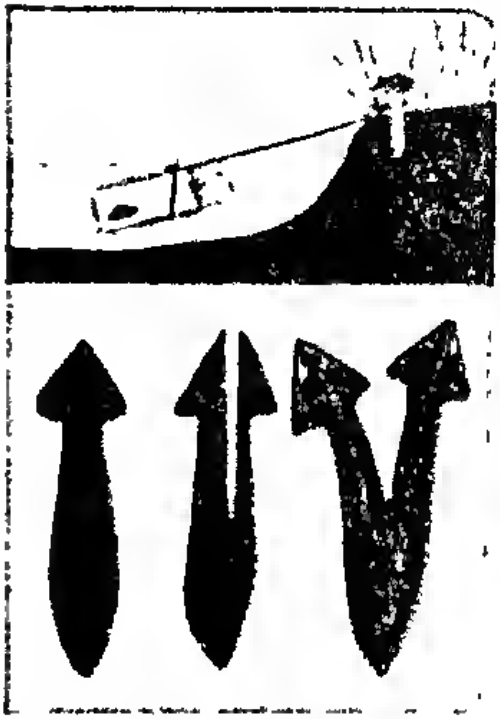
Planaria are famous among biologists for their ability to regrow new parts, a process called REGENERATION. If its head is cut off, a specimen will soon grow a new one; and the head piece may even regenerate a new tail. Also, if its head end is cut through vertically with a sharp knife, the split animal will, in a few days, grow into a two-headed worm. Cut-off head pieces can be grafted onto other body regions or onto another flatworm and these usually will grow where placed.

The whole regenerating ability is quite natural to planaria, for a full-grown animal can, by itself, slowly pull itself into two halves which will soon grow into two complete animals.

P. A. P.

☀ THINGS TO DO

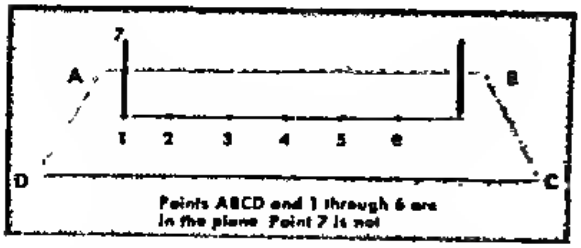
WILL A WORM GROW TWO HEADS?



1 Planaria may be purchased from a supply company or may be found in quiet streams and collected in the following way. Put a piece of raw liver in a tall olive bottle. Cover the bottle's mouth with a wire screen to prevent larger animals from getting the food. Tie a cord around the bottle and lower it into the water. The other end may be fastened to a stake driven in the ground on the edge of the bank. It could take several hours before planaria find the liver. Check periodically for signs of a capture.

2 Transfer the planaria to a shallow dish of fresh water for its future home. To demonstrate its remarkable powers of regeneration place a planaria on a hard surface. With a sharp razor blade make a cut half way down its anterior end. Place the planaria back in the dish of water.

3 It will take about two weeks for each half to grow its other half. As soon as this is apparent feed it raw liver again. Leave the food in for an hour, then remove it to prevent spoilage.



A plane surface

Plane A plane is a flat surface which has length and width but no thickness. On a plane surface every point on a straight line joining two points lies entirely within the surface.

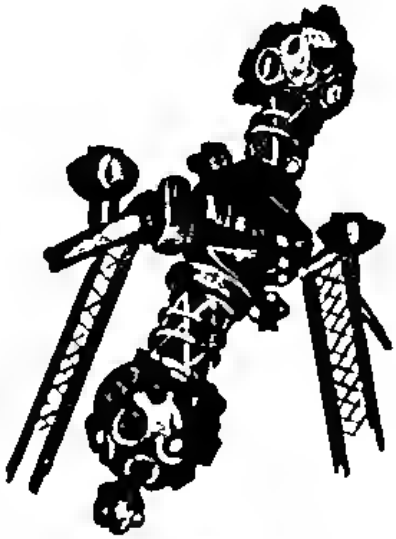
SEE: GEOMETRY

Planet The name "planet" comes from a Greek word meaning "wanderer." One can easily see how a planet moves among the stars in a regular path if one watches the sky for a few nights.

The nine planets that revolve around the sun can be distinguished from stars by their changing positions among the stars. The stars, which appear fixed, give off their own light, while the planets do not. Like the earth and moon, planets shine by light reflected from the sun. When seen through a telescope, a planet looks like a ball; with the exception of the sun, stars look like pin points of light because they are so far away from Earth.

Planets travel in a path which is called an *orbit*. This ORBIT is around the sun, and is nearly a circle. Actually this orbit is a somewhat flattened circle, or *ellipse*. Although the planets move in the same direction, their orbits are different distances from the sun. Some of the planets, particularly the *terrestrial* or inside group, are made of heavy atoms of matter. The *Jovian* planets or outside group seem to be made of lighter atoms. All of them rotate on their axes, but at different rates. All the planets' orbits are about in the plane of the sun's equator, though Pluto's orbit is tipped.

SEE ALSO: EARTH, SOLAR SYSTEM



A planetarium projector

Planetarium (plan-uh-TAIR-i-um) A planetarium is a machine inside of a dome-shaped building that can show the sun, the moon, the planets, and the stars. It portrays how all these heavenly bodies move. A planetarium is different from a telescope because a telescope can show a real but very small part of the sky. The planetarium actually makes a large artificial sky appear on its giant domed ceiling.

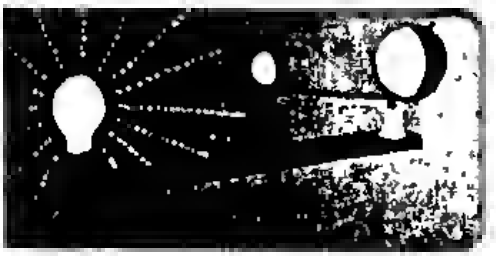
A planetarium can speed up, slow down, or stop its picture of the sky in action. It can show how the sky looked hundreds of years ago, how it looks now, or how it will look thousands of years in the future. It can show how the sky looks from any place on Earth. A person can sit in Adler Planetarium in Chicago, for instance, and look up at the domed ceiling and see a picture of how the sky looked in Egypt in 2000 B.C. He can see how the sky looks now from the South Pole, or he can see the sky that his great-great-grandchildren will be able to see.

A planetarium can depict the moon going rapidly through its phases. It can show a planet moving from one constellation to another, and the constellations rising and setting.

Modern planetariums can portray all of the heavenly bodies that are visible to the naked eye. The machine that projects the image of the sky is made up of many projectors. Like slide projectors, it casts over

✳ THINGS TO DO

CONSTRUCTING A PLANETARIUM



1 Secure a large rubber ball and a small one which is one-fourth its size. These will represent the earth and moon.

2 Insert a wire hanger through the center of both balls. Construct a wooden arm on to a table lamp by following the adjoining illustration. A large eye screw will permit the arm to revolve around the light which represents the sun. A spool nailed to the opposite end of the arm will hold the wires which are attached to the two balls.

3 The axis of the earth should always be tilted to the north as you revolve it around the sun. Observe the area on the earth which is directly illuminated by the light at each quarter turn. Can you figure out which season of the year it is? In what positions will the moon be when there are lunar and solar eclipses?

one hundred. Each projector's picture is a "still" picture. Some are spots of light that represent the sun, the moon, or the planets. Some of them are pictures of groups of stars. The pictures are fitted together to make a single, accurate picture of the night sky. Then, by means of electric motors, the projectors can all be moved to show the individual motions of the heavenly bodies. The complete machine is moved, too, to show the effects of the earth's rotation.

A typical modern planetarium can show over 9600 stars. It has over 100 separate images in each complete sky scene. The first modern planetarium was built in Munich, Germany, in 1923. Many major cities have them now for both public use and research. In New York City there is the Hayden Planetarium; Los Angeles has the Griffith Planetarium. Fels Planetarium is in Philadelphia. C. L. K.

SEE ALSO: OBSERVATORY, TELESCOPE

Planetoid see Asteroid

Plankton Most living things in the sea belong to a group of plants and animals called plankton. This name refers to the countless marine plants and animals that are free in the water and are carried along by currents. Those organisms, especially animals, that actively swim at the surface of the water are called *nekton*.

There are a few fairly large types of plankton, such as the sargassum plants and the JELLYFISH. However, most of the organisms classed as plankton are very small. These range from the *copepods*, which are barely visible, to the microscopic forms called *diatoms* and BACTERIA.

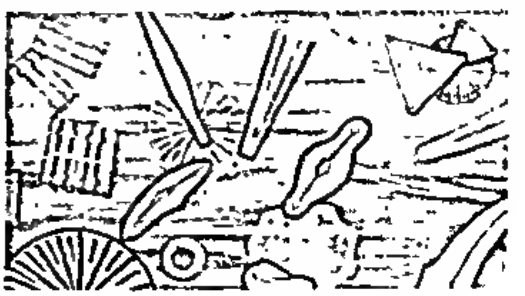
The animal representatives of plankton are one-celled PROTOZOA and the larvae of such forms as oysters, snails, fish, and worms. These forms of plankton are a very necessary food supply to the fish of the sea. Small fish, as well as some very large whales, feed entirely on plankton. Larger fish feed upon the small fish. Eventually man uses some of the larger fish as a source of his food supply.

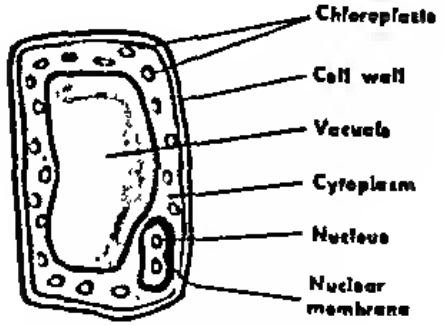
The terms *limnoplankton* and *haliplankton* are sometimes applied to fresh-water and marine organisms, respectively. There are also other subdivisions. V. V. N.

SEE ALSO: DIATOM, MARINE BIOLOGY, OCEANOGRAPHY

Ocean phyto-plankton consists of many tiny organisms, including diatoms

Courtesy Society For Visual Education, Inc.





Parts of a typical plant cell

Plant Plants were probably the first form of life to appear on this earth millions of years ago. They may be so small one cannot see them without a microscope. It would take 50,000 bacteria lined up in a row to measure one inch. The largest plants are the giant sequoia trees in California. Some of these are as tall as a twenty-four story building.

Plants are living things since they are made of cells, can grow and reproduce. They carry on most of the same life processes as animals. They are different from animals in several ways. They have chlorophyll and can make their own food. There is a wide range of size in plants of the same kind. The higher plants cannot move around from one place to another.

CELLULAR STRUCTURE

All plants are made of cells. The whole plant may be only one cell, such as unicellular green ALGAE. Most plants though are made up of thousands of cells, with each cell designed to do a certain job for the entire group of cells. Plant cells may be microscopic in size or as long as twenty inches.

Most plant cells have a nonliving wall of *cellulose*, a complex carbohydrate. This material makes them more rigid than animal cells. The *cytoplasm* and *nucleus* surround a central *vacuole* of cell sap. A number of bodies are found in the cytoplasm which are lacking in most animals. *Plastids* help make food, store starch, and contain the colored pigments. The cytoplasm's primary purpose then is to make, store, and digest food.

The nucleus of a cell is the "team captain," controlling most activities carried on in each cell. It contains *chromosomes*, the bearers of hereditary characteristics. Plant cells may have from one to a thousand pairs depending on the species. They usually average from five to fifty pairs. The *life span of* plant cells varies. Some live only hours while others continue to function for hundreds of years.

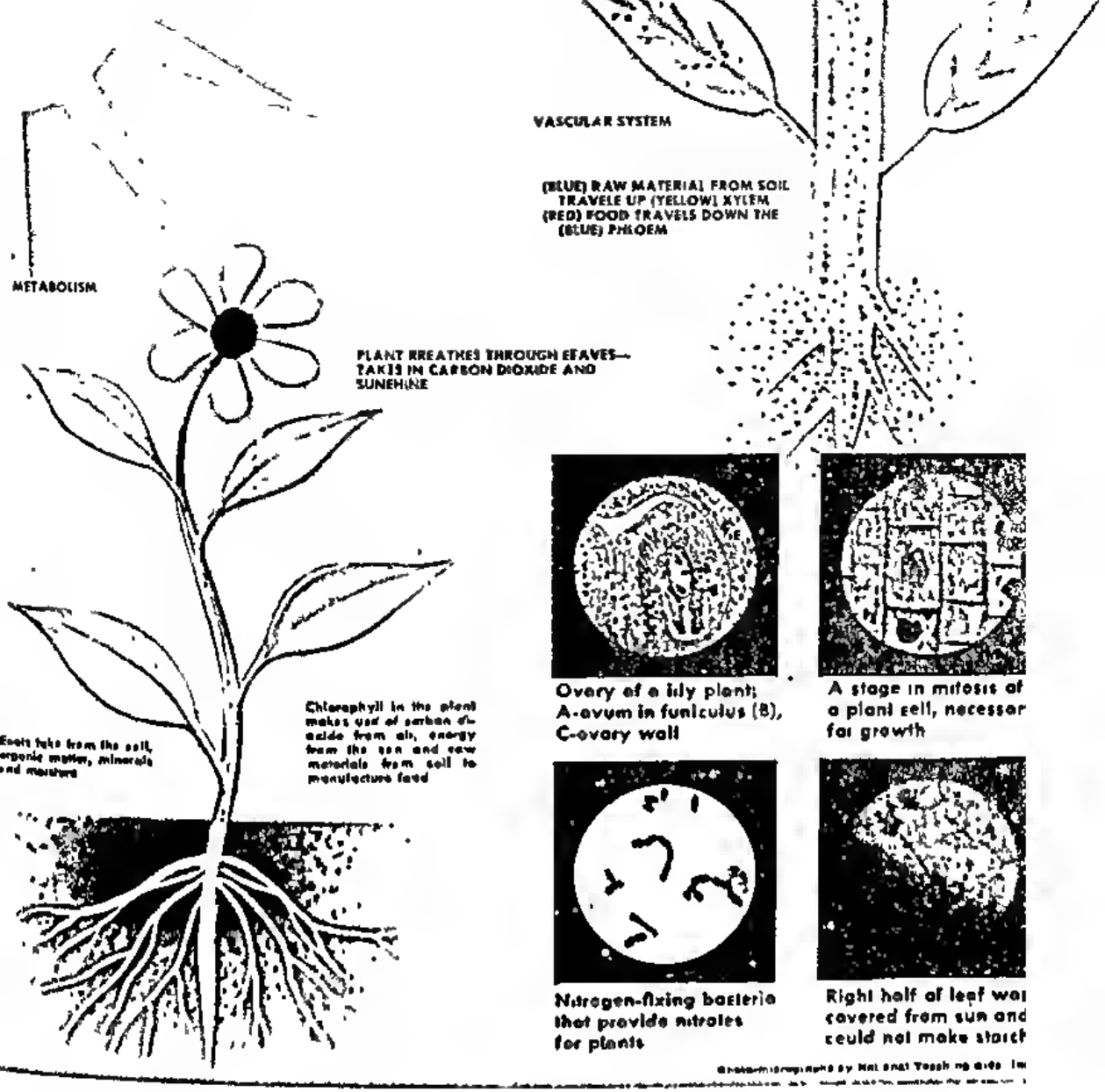
METABOLISM

Plants must eat, drink, breathe, and burn up energy. They have one big advantage over animals since most plants make their own food. Plants cannot move and must depend upon the ATMOSPHERE to give them water and fresh air. They use less energy than animals because they do not move from place to place.

METABOLISM is the sum total of all the plant processes necessary to keep it alive. Those activities which build up cells by making complex material from simple materials are termed *anabolism*. Photosynthesis and assimilation are anabolic processes. By contrast, the tearing down of protoplasm, making simple materials from complex materials, is *catabolism*. Digestion and respiration are catabolic processes.

Unicellular plants carry on all life activities within a single cell. This would make this little mass of protoplasm much more generalized than any one cell found in the higher plant groups. Multicellular plants divide up the metabolic responsibilities among the cells. The roots of plants assume the task of anchoring the plant and absorbing the water and minerals from the soil. The stems support the leafy crown and conduct raw materials up to the leaves and, in turn, transport the manufactured food throughout the entire plant. Leaves carry on PHOTOSYNTHESIS, food making, and TRANSPIRATION, release of excess water. The gaseous exchange occurs through minute holes on the leaf.

Materials necessary for metabolism are received and transported in a number of ways. One-celled plants absorb and excrete through the cell wall. Simple multicellular plants pass the material from cell to cell. Higher plants have developed a *vascular or* conducting system. A variety of tubes and vessels are designed to permit a more rapid and continuous flow of raw materials and food products from one part of the plant to another. The *xylem* tissue in the root con-



tinues up the stem, out the *petiole* and through the leaf. *Phloem* tissues form a continuous pathway in the reverse direction, leaves to stems to roots.

Plants give off oxygen in the process of photosynthesis, and like animals, also release CO_2 in respiration and use O_2 for the oxidation of food. While photosynthesis is taking place during daylight hours, more oxygen than carbon dioxide is released.

GROWTH

Man and other animals do not grow to be tall giants if they eat and eat. Plants, however, do not stop growing if they are fed and watered more than usual. A geranium growing in Michigan may not get any taller than two feet. This same geranium living in a climate where there is a longer growing season, as in California, may grow taller than a human giant.

Plants will increase their size in only certain areas. *Meristematic* cells will divide to increase a plant in length and circumference. These four regions are the stem tip, ROOT tip, vascular cambium and cork CAMBIUM. Multiplication of cells occurs more often during the night, because the plant is busy making food during the daylight hours.

Two factors affect the growth in plants. *Genetically* they inherit qualities which affect their size. One can buy seeds to grow giant zinnias or dwarf phlox. Internal cellular activity is another genetic factor. The amount of plant-growth hormone, *auxin*,

produced by the cells controls the extent of growth. Finally, the external environmental conditions play a part. Plants given the right amount of water, light, air, warmth and FERTILIZER will thrive better than those deprived of one or more of these.

Most plants will not live forever. There is a certain life span for each kind. ANNUALS will produce seed the first year they are planted. They have completed their life cycle and die. BIENNIALS grow and store food the first year, bloom and produce seeds the second year before they die. PERENNIALS will produce seeds year after year and have a rather indefinite life span. It is reported that some sequoias are 4000 years old.

REPRODUCTION

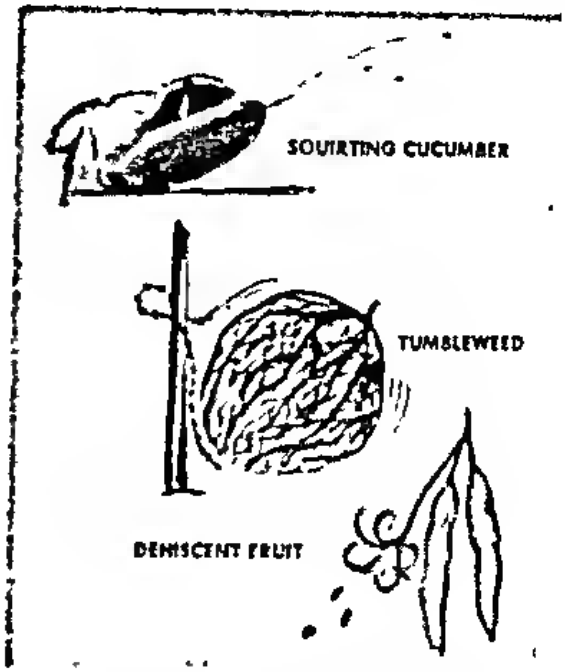
Plants must make more of their kind or they would soon disappear from the earth. The little one-celled plants just squeeze apart and make two of themselves. Many plants must make two kinds of cells, an egg and a sperm. When these two cells come together the resulting cell will begin to grow into a new plant. New plants usually look like the parent plants.

Plants reproduce asexually by fission, SPORE FORMATION, or by PROPAGATION. Fission is simple division of a cell as in bacteria If environmental conditions are controlled, bacteria will divide every half hour. This does not appear phenomenal unless one counts the offspring produced in a day and a night. The 48 generations would number 256,000,000,000,000 bacteria.

Spores are cells produced by many plants, such as fungi and one generation of the mosses and ferns When environmental conditions are adverse, some plants may form spores that have a rather thick wall. This is a protective device of the plant against extreme heat or drought. When conditions are more favorable the spore breaks from the shell and germinates.

Propagation of vegetative parts of a plant (root, stem, or leaves) may be done by the plant itself or by man. Many plants will form extra little bulblets. Drooping branches of weeping willows will take root if they come in with the ground. Strawberry crab grass send out runners. New plants arise at the nodes. Man uses root and stem cuttings (slips) to plant the same species.

Some plants reproduce sexually by production of either motile or non-motile sex cells or gametes—eggs and sperm. Conjugation is the union of two sex cells that look alike. Fertilization is the combining of sex cells which can be distinguished as male and female. Sometimes the sexes may be on the same plant as in the apple tree. The ash has male trees (*staminate*) and female trees (*pistillate*)



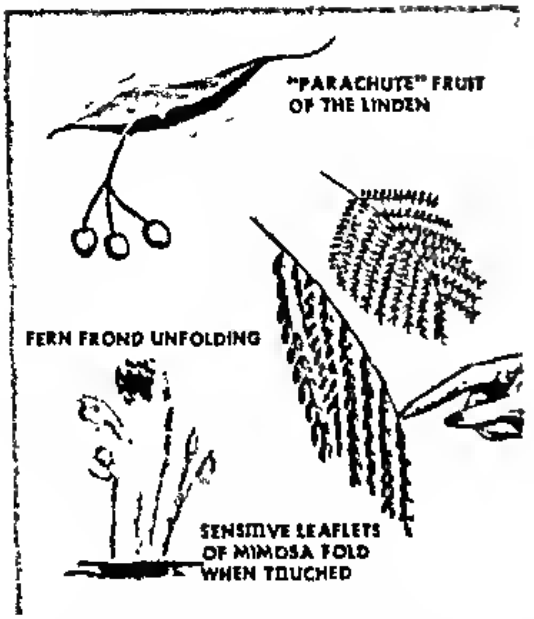
Some unusual types of seed dispersal

ADAPTATION

Plants cannot fly south when winter comes as birds do. They are not able to move into the caves or other shelters to hibernate as some animals do when food and warmth are scarce Since plants cannot move they must adapt to all kinds of conditions Plants that do not adjust to the environment soon die

Plants go through seasonal adjustments according to their location Floral life in California will grow mainly during the wet, cool winters. The hot, dry summers slow growth considerably, almost to inactivity Many trees lose their leaves during this time Plants in the frigid zones have adjusted their life activities to a very short growing season as the summers are short and the winters extremely long In the equatorial rain forests plants respond by growing almost continually The forest is very dense and the undergrowth of small plants have adapted to surviving in dense shade

Another adjustment by plants is the storage of food and water for future use Some



could compare it to animals' preparation for the long winter months. Biennial plants die back to ground level with the roots storing enough material to start the plant on its second year of growth. Some perennials lose their aerial parts when winter arrives and store food in underground stems or roots. Other perennials, such as trees and shrubs, drop their leaves in fall. Roots are unable to absorb water from the frozen ground and must protect themselves from water loss in the leaves.

LOCOMOTION

Most plants do not move from place to place. This is one of the main ways one can tell a plant from an animal. A few of the simple one-celled plants are able to swim or crawl. Nevertheless they are still called plants. Plants are able to bend or turn in different directions. This helps the plant get the things it needs to live.

There are two kinds of movements that stationary plants exhibit. Some movements are due to unequal growth rates in cells and are called TROPISMS. Plants respond in the direction of growth to the direction of the stimulus. If the parts of the plant turn toward the stimulus this is a *positive* response, while moving away is a *negative* response. Stems and leaves turn toward the light but roots grow away from it. Roots grow with the pull of gravity while stems grow up and away from the earth.

Nastic movements are independent of the direction of the stimulus and are characteristically due to changes in *turgor pressure* (water content of the cells) rather than to growth. These are usually temporary or cyclical movements. Flowers open and close periodically. These are called *sleep movements*. If an object touches the leaves of the mimosa plant, they fold up in seconds. When an insect starts to crawl through the Venus' flytrap or sundew the trap folds up, catching the insect inside.

Time-lapse photography reveals the constant motion of plants. Tropic and nastic movements, not always visible to the naked eye, when recorded on film show the plant dancing in tune under the direction of nature's environmental factors. H. J. C.

SEE ALSO: CELL; CELLULOSE; CHLOROPHYLL; HEREDITY; LEAVES; LIFE, CHARACTERISTICS OF; PLANT TISSUES; PLANTS, CLASSIFICATION OF

The roots on these seedlings are growing downward in response to water. The stems will grow toward the sun. These are tropisms

Apple cedar rust spreads from red cedar to apple trees

Plant diseases Plants have diseases just as animals and people do. These plant diseases come from bacteria, infected seed, lack of room, too little or too much light and moisture, heat, frost, or poor soil. The records of the early Greeks and Romans show that plants had diseases found today, such as *rust* and *mildew* or *blight*.

There are times in history when people have starved to death because of serious outbreaks of disease. When the potato crops in Ireland failed in 1845 because of disease, there were many human deaths. Through the years, scientists have been working to learn more about plant diseases, and today many methods of control have been discovered to protect grains, fruits, and vegetables that are so important to animal and human life.

A plant is a delicate and complex machine. Young plants are more apt to get diseases because of poor soil and weather conditions than are older plants. The young cereal plants are more susceptible to smut than older plants. Wood rot fungi may enter a plant when there has been a wound or a mechanical injury to the plant. Plants that have been chilled by frost are subject to fungus infections. Root injuries and poisonous materials in the soil can contribute to diseases of plants. Burning or scalding of the leaves of plants will cause a diseased condition. This happens when there is a sudden change from cloudy, moist weather to clear, hot weather. Severe winter weath will cause frost-cracks and frost canker plants and trees.

Sooty MOLDS on the surface of leaves a fruits will starve the plant. These bla mold-like fungi cover the surface of t leaves so that the chloroplasts lose the green color, and the formation of starc and sugar is so greatly reduced that th plant cannot grow.

Bacterial diseases include the black rot c cabbage, pear or fire BLIGHT, and crow galls of the apple trees. The pear blight at tacks the blossoms and young twigs, kill them, and turns them black. The tree look as though it had been burned. The bacteria causing this blight may live for years in cankers on the limbs and trunk. The germs stay in a sticky gum that comes out of the cankers. Insects carry these germs from tree to tree. So far, no effective spray has been found to attack the pear or fire blight. It can be controlled by "operating" on the tree. Tools must be sterilized and the infected parts are cut out. Brown rot causes the most damage to peach trees. It makes the fruit rot and shrivel and become covered with olive-gray spores of the FUNGUS.

Stem rust, wheat smuts, and ergot are common diseases of cereals and grains. Rust is the most destructive disease of wheat. It causes small, rust-colored spots on the leaves, stems, and heads of wheat. There are two important kinds of rust—stem rust and leaf rust. There is little a grower can do to prevent these rusts except to destroy such plants as barberry which help grow the rust that later spreads to the wheat. Scientists have been successful in developing varieties of wheat that resist rust.

Apple trees and their fruit are attacked by many different diseases. The most important are the apple scab, cedar rust, and fire blight. The apple scab is a fungus which causes black spots on the leaves and blossoms and makes the apples spotted and poorly shaped. It can be controlled by spraying the tree with sulfur or copper. The cedar rust fungus, like the wheat rust, is grown on another plant and carried to the apple tree. In this case, the cedar rust spends part of its life on red cedar trees. Apple growers cut down all red cedars within three miles of their apple orchards to prevent the cedar rust disease.

Potato blight is one of the most destructive fungus diseases. The fungus grows on the leaves, and can be spread from plant to plant by wind or splashing of rain

Scale insects suck plant

The boll weevil ruins cotton plant b

Caterpillars damage plants by eating leaves

VIRUS diseases cause various leaf mosaics and other infections in many of the most popular, edible fruits and vegetables Certain parasites such as mistletoe, broomrapes, and dodders rob the host plants of their food so that the hosts eventually become diseased.

There are almost as many plant diseases as there are plants Some plants are attacked by one disease; some are victims of many. Botanists, farmers, growers, gardeners, and the United States Department of Agriculture are constantly seeking new methods of controlling plant disease Some of the old methods which have been successful are the selection of disease-free seed, quarantine of diseased plants, development of resistant strains, rotation of crops, and the use of powders and sprays.

SEE ALSO PARASITE, RUST J. K. K.

Plant hormones see Hormones, plant

Plant pests In addition to the many different kinds of plant diseases, there are a great number of plant pests that can destroy or stop the growth of plants. Insects, especially, carry many of the fungi and bacterial diseases from plant to plant. Bees carry the pear blight even though they do help in the pollination of the trees. The potato beetle carries the potato rot. Boring beetles spread ferment and woodrot fungi.

Insects injure plants when they feed on them Biting insects such as certain grasshoppers can strip a plant of its foliage, thus killing it Sucking insects and mites cause damage to plants by reducing their store of plant food, in which case the plant will stop growing and eventually die Scale insects mealy bugs, plant lice, leaf hoppers, and "plant bugs" are the most destructive kinds because they suck the sap out of the plant tissues Sometimes this only slows up the growth process, but other times it causes irritations by some material the insect may inject into the tissues of the plant Then, the roots or leaves of the plant may develop gall-like sections Common injuries of this type are the *Phylloxera* (grape lice) on the leaves and roots of grapes, woolly aphis louse on the roots of the apple, and elm comb gall on the elm

The plant's tissues at cells are also caused by insect larvae developing from eggs

Corn borer

laid in young tissues of a plant. Thousands of plants are attacked by nematode worms which go after the roots and cause gall-like swellings. These worms invade field and truck crops.

Borers injure their host by cutting off the flow of food between the root and leaves of a tree or plant when they bore rings around the trunk or stem. The corn borer is blamed for a great loss of corn corps each year, and this is true; but actually, corn is a favorite food of over 350 other insects. Some of them are the corn-ear worms, chinch bugs, grasshoppers, and the white grubs. The boll weevil does great damage to the cotton crop in the United States each year. It feeds on the silky fiber inside the seed pods or bolls of the cotton plant.

Most birds are friends to the farmers and gardeners because they eat insect pests that are harmful to the crops, but there are some birds which are harmful and are considered plant pests. The crow goes after the farmer's corn crop, and other birds eat or damage fruit in orchards and vineyards. Small animals, mainly in the rodent family, eat grain in the fields and vegetables in the truck gardens. J. K. K.

SEE ALSO: PLANT DISEASES

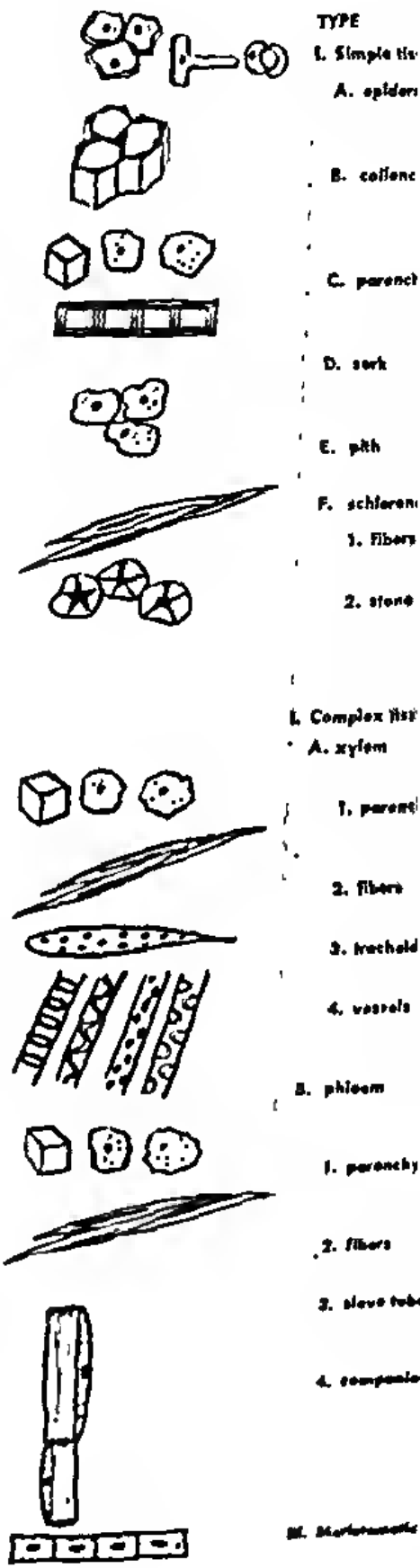
Plant tissues Most plants are made of many cells. These cells are usually organized into groups called tissues. If a group of cells is basically alike, it is called simple tissue. Complex tissues are made of different kinds of cells which do the same job.

Some tissues appear in all organs of a plant; the stem, root, leaf, fruit, and flower. Other cell groups are so specialized they occur in selected parts of a mature plant. Each kind of tissue has the cellular composition to do a particular function for the life of a plant.

The adjoining table outlines the kinds of ...nd in complex plants, their Life ...tion, and appearance. H. J. C.

:: PLANT

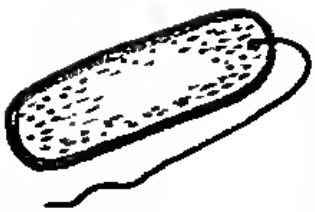
aquarium See Aquarium, ...cal Fish



OF TISSUES IN PLANTS

LOCATION	FUNCTION	LIFETIME	APPEARANCE
outer layer of plants, fruits, leaves	protective and absorptive	living when functional	irregular shapes may have cutin on outside
many parts of entire plant beneath epidermis of herbaceous stems, petioles, midribs of leaves	strengthening	living at maturity	prism-shaped, elongated, more cellulose in angles of cells
all organs, most common	conductive and storage	usually living	isodiametric, spherical, cubical, many-sided
outer layer of woody plants	water proofing protective	most functional after death	rectangular or box-shaped thick walls of suberin
center core of young plants	food storage	living when functional also in plant matures	large, thin-walled cells
	strengthening		
many parts of entire plant		cell contents die at maturity	long, slender, thick-walled
many parts, especially fruit walls		cell contents die at maturity	short, irregular shapes
extend through all parts			
	food storage and conduction	usually living	isodiametric
	strengthening	usually dead at maturity	long, slender, thick-walled
	conduction	usually dead at maturity	long, tapering, pitted walls
	conduction	usually dead at maturity	chain of long cells, lack end walls
extend through all parts			annular, spiral, scalariform, pitted
	food storage and conduction	usually living	isodiametric
	strengthening	cell contents die at maturity	long, slender, thick-walled
	conduction	living at maturity	rows of long cells, ends perforated to form a sieve
	helps sieve tubes	living at maturity	long, tapering cells, dense cytoplasm, prominent nucleus
root tip, stem tip — increase length; cork cambium, vascular cambium — increase circumference	increases plant growth in length and circumference—cell multiplication	living when functional	rectangular cells

Alga



Bacterium

Slime mold

Fungi Imperfecti

Plants, classification of While hiking through the United States, one would have difficulty finding a plant that has not been discovered and given a name. The unexplored tropics, though, would prove good hunting grounds for new plants. Every plant that man finds is given two names in Latin or Greek. For example, in France, Australia, or Brazil, *Rosa alba* is a white rose. Over 350,000 plants have been named so far. There are many more to be discovered.

Today plants are classified according to their basic structure and life history. Theophrastus, called *"father of botany,"* was the first scientist to start a classification system, and some of the names he gave plants are still used today. During the Middle Ages man grouped plants according to their uses: medicinal plants, food plants, or harmful plants. This is considered artificial classification. In 1753 CAROLUS LINNAEUS formed a natural classification system based on the number of floral organs. Plants were grouped according to basic similarity of structure.

Plants of relatively like structure and function are classified in the same *species*, related species into a *genus*, genera grouped into *families*, and these into *orders*. Similar orders are placed into *classes*, which are finally classified into divisions called *phyla*.

Taxonomy is a variable science and al-
ging because scientists disagree
are discovered.

est FOSSIL plants date back 500
to the Cambrian period. *Coral-*
ich are algae, were uncovered. This
life evidently was well established be-
the first marine animals. It is believed
land plants made their appearance about 350 million years ago. It has been difficul to trace the ancestral progression of exist ing plants since the soft tissue of man have not left fossil prints. Therefore, ther are gaps in the chain of evolution. However as plants are studied from simple to com plex forms, some pattern or thread is found that runs throughout.

ALGAE

The green scum on ponds and the green film that appears in an aquarium is probably some form of algae. They are among the simplest plants that can make food. The entire body of many algae is only one cell. Some cells tend to hang together and form a string or filament. Even when the algae are made of many cells, each cell looks and acts very much like all the others. They do not have roots, stems or leaves.

Algae are put into groups or classified by their color (pigmentation), by the kinds of food they store, and by the kind of cell movement. Algae have one-celled sex organs, or if the organs are multicellular, each cell forms a sex cell. They reproduce asexually by *fission* and by *fragmentation*.

The *blue-green* algae lack an organized *nucleus* and *plastids*. They appear to be the simplest plants within the algae group. The *flagellates* move about and for this reason they are also claimed to be animals by zoologist. The *diatoms* have secreted walls of *silica*. Many move with flagella or an ameboid action. They leave fossil remains. Brown algae are multicellular. The giant KELP of the Northern Hemisphere may reach a length of 150 feet. The Sargasso Sea gets its name from a brown alga called *Sargassum*. Red algae are multicellular organisms found at greater depths in the ocean than any other plant. Irish moss is a type of red algae.

BACTERIA

Bacteria are often called "microbes" or "germs." They are the smallest living thing

KINGDOM, PLANT

SUBKINGDOM, THALLOPHYTA

Division, Cyanophyta (blue-green ...

Division, Euglenophyta (euglenoids

Division, Chlorophyta (green algae

Division, Chrysophyta (diatoms, yellow-green and golden-brown algae)

Division, Phaeophyta (brown algae)

Division, Rhodophyta (red algae)

Division, Schizomycophyta (bacteria)

Division, Myxomycophyta (slime mol

Division, Eumycophyta (true fungi)

SUBKINGDOM, EMBRYOPHYTA

Division, Bryophyta (moss, liverworts)

Division, Tracheophyta

Subdivision, Psilopsida (fossil forms, two living genera)

Subdivision, Lycopsida (club moss)

Subdivision, Sphenopsida (horsetails)

Subdivision, Pteropsida

Class, Filicinae (ferns)

Class, Gymnospermae (conifer, ginkgo, cycad)

Class, Angiospermae (flowering plants)

Subclass, Monocotyledoneae

Subclass, Dicotyledoneae

the world Only a few have CHLOROPHYLL. hey grow in three shapes, round, rod-like, r spiral.

Bacteria usually exist as single cells hough some form filaments or colonies. They lack a true nucleus and cellulose in their cell walls. Some are able to move by means of projections called *flagella* or *cilia*. Most of these plants are parasitic or saprophytic. A few bacteria can make food and get energy by a process called *chemosynthesis*. It is believed that bacteria are related to the blue-green algae.

SLIME MOLD

This plant creeps along much like the movement of an ameba. It is a slippery, colorless mass of protoplasm. Slime mold is difficult to classify. The reproductive stage is plant-like, while the vegetative stage is animal-like. Therefore, it has received the description of a *fungus-like animal*.


FUNG
FERN

Lichen

Fungi

Mosses and liverworts

Club moss

FUNGI IMPERFECTI

The plants in this group are not perfect. They lack the sexual stage in their life cycle. Members of the group include *Penicillium* and other blue-green molds, apple blotch, and a fungus that causes fever and a lung disease in man.

LICHEN

This plant is a combination of plants that could be compared to a happy marriage. Just as the man brings home the bacon and the woman cooks it, so the fungus, one of the pair, gathers the water and minerals so the algae can make the food. This living together of two different plants, where one helps the other, is called *symbiosis*.

Lichen grows slowly and in such bleak areas it does not have to compete with more vigorous plants.

FUNGI

Some people train their pigs or dogs to find a fungus plant that is good to eat. These plants are called *truffles*. The entire lives of these plants are spent under the ground. They give off strong odors.

The true fungi are the largest group of plants without flowers. They do not have chlorophyll. Many fungi are single-celled, but a *puffball* was found that was one foot high and four feet wide.

Fungi, with the exception of YEAST, are generally classified according to form and life history instead of function. They lack roots, stems, leaves, and conducting tissue. Usually the plants have two parts: the *vegetative*, consisting of filaments which anchor and absorb, and the *fruiting body*, which does the reproducing.

Fungi usually reproduce by spores. A mushroom will produce as many as two thousand million spores. Some fungi propagate by making a massive ball of *hyphae* (cellular elements). This ball forms a ground root. Some are as large as [illegible]'s and are eaten by Australians who call them "bladderless' bread".

Many fungi go from one host to another to finish their life cycle; this is called *alternation of hosts*. Wheat rust needs the barberry bush and wheat. The white pine and gooseberry exchange a fungus growth, as do the cedar apple and juniper. The most efficient way to control this alternating fungus pest is to eliminate one of the hosts and halt the cycle.

True fungi include mushrooms, toadstools, tree brackets, smuts, morels, milldews, stinkhorns, ergot, and the beautiful little earthstar.

MOSSES AND LIVERWORTS

These little green plants have parts that begin to look and act like leaves, roots, and stems. Some of the cells in this group are now doing different jobs for the whole plant.

Moss reproduces by two alternating stages. One shoot of the plant forms eggs while another one makes sperms. Water is needed to carry the sperm to the egg. The fertilized egg germinates, forming a stalk with a capsule on the end. This plant (*sporophyte*) must live on the female plant (*gametophyte*). When the spores are released they will form the male and female plants, thus continuing the cycle.

Different species of moss are grouped according to the position and arrangement of leaves and the shape of the capsule.

CLUB MOSS

Club moss in general appearance resembles true moss but has cones or clubs of spore-bearing leaves. Their *life history* is similar to ferns but differs in several ways. The spores may not germinate for five years and then do so underground. The *prothallus* grows very slowly, with the sex organs appearing sometimes a dozen years later. After fertilization of the sex cells, a sporophyte germinates. This is the familiar club moss.

HORSETAILS

Horsetails are closely related to the ferns, with much the same life cycle. They have underground structures as do the ferns

They have an erect, jointed shoot instead of compound leaves. There are whorls of little branches around each joint. Cone-like structures produce the spores. Some kinds in tropical America are thirty feet tall.

FERNS

These plants have true roots, stems, leaves, and conducting tubes. The LEAVES are compound, meaning many little leaflets on a stem. This makes them more like the flowering plants. Many FERNS have stems underground, with only the leaves (*fronds*) above the soil. A few fern stems have reached a height of sixty feet and a width of two feet. This is unusual, however.

There are two plants in a fern's life cycle. The spore germinates into a tiny, heart-shaped *prothallus*. It produces sex cells. Ferns, as mosses, are still dependent upon water for fertilization, to carry the sperm to the egg. The fertilized egg develops into a spore-forming plant (the conspicuous fern plant), which is independent. This is an advance over the *moss cycle*.

GYMNOSPERMS

These plants are woody trees, shrubs, and vines. They are missing the flowers and FRUITS. This is the first group to have seeds. The seeds are not enclosed in a pod, nut, or other organ. Most of them are "evergreen," which means they do not lose their needles or leaves every year. The larches and bald cypresses are exceptions.

Cycads are one of the most primitive seed plants dating back to the Mesozoic Era. They usually have large fern-like leaves, an erect stem, and a tap root. They develop cones in the reproductive cycle.

Ginkgo's have thin, fan-shaped leaves that resemble the maiden-hair fern. The sexes are on separate trees. The male tree has drooping *strobili* (cones). The female tree develops a fleshy covering over the seeds which looks like a yellow mottled plum. This is not classified as a true fruit.

The conifers (cone-bearers) include the pine, hemlock, spruce, fir, juniper, and many others. Most of them bear both sexes on the same tree but in different catkins. They produce two kinds of spores. The pollen grain is the male gametophyte, while the ovule is the female. The union causes the embryo development which, when mature, is the seed.

ANGIOSPERMS

Any plant with a flower belongs in this group. Man has discovered and named more ANGIOSPERMS than all the lower plants put together. They are the most complex and most recent plants in the world. They are adapted to living in a wider range of places than any other single group.

Flowers may be large and conspicuous or small and less striking. Most angiosperms have the STAMEN and PISTIL on the same plant and frequently in the same flower. A flower is *complete* when it has all floral parts, *incomplete* when one or more is missing. A perfect flower has both stamen and pistil, while an imperfect has only one, as in the willow, poplar, and mulberry trees. Only in the flowering plants is there double fertilization. One sperm in the POLLEN grain unites with the ovum in the ovary to form the embryo. The other sperm joins the polar nuclei to form the *endosperm*. This feeds the embryo.

Angiosperms are separated into two groups. *Monocotyledons* have one *cotyledon*, leaves with parallel venation, flower parts in multiples of three, vascular bundles in the stem, no cambium, and include such plants as grasses, lilies, and orchids.

Dicotyledons have two cotyledons, leaves with netted venation, flower parts in multiples of four or five, vascular bundles in a ring, a cambium for secondary growth, and include such plants as legumes, roses, mint, and most forest and fruit trees. H. J. C.

SEE ALSO: ALTERNATION OF GENERATIONS; EMBRYOPHYTA; EVOLUTION; GEOLOGIC TIME TABLE; PLANT; PLANT TISSUES; REPRODUCTION, ASEXUAL; REPRODUCTION, SEXUAL; THALLOPHYTA

Courtesy Society For Visual Education, Inc.

Leaves of Venus' flytrap close on insects

Plants, insectivorous (in-seck-TIHV-uh-ruhs) Some plants have the ability to trap insects and digest them. Most of these plants are small. They are found in swamps or bogs, or in dry, rocky places.

There are over five hundred different kinds of insectivorous plants. Although these plants are green and capable of manufacturing their own food, they have leaves that can trap insects and small animals. These insectivorous plants even secrete a juice that digests and absorbs the animal remains.

Most of the insectivorous plants are found in five families of dicot angiosperms. The bladderwort family includes common aquatic and amphibious plants, such as the bladderwort and butterwort. There are three families of PITCHER PLANTS; the common pitcher plant of the swamps and bogs of the United States and Guiana, a single species of pitcher plant found in the Australian bogs, and in the tropics a family of pitcher plants with elaborate and brightly colored pitchers for catching animal food. The most highly developed of all the insectivorous plants are found in the sundew family, among whose members are many clever devices for trapping small insects. Members of the sundew family include the sundew, the flycatcher, and the very remarkable VENUS' FLYTRAP. M. R. L.

Plants, medicinal Since ancient times when man first gathered the seeds, stems, leaves, and roots of plants, he has tried to use them to cure illnesses. Early man would boil, dry, or powder the plants to make herb medicines.

Some plants used to obtain medicines: (from left) coffee, cinchona, poppy

In modern times, medical scientists have found that some of these plants proved useful, while others either needed much refining or were useless, or perhaps even harmful.

One of the old plant medicines scientifically proved valuable is QUININE. When the Spanish explorers came to Peru in the sixteenth century, South American Indians were using cinchona tree bark with its quinine to treat "swamp fever." Quinine is still one of the best drugs for malaria.

Two long known beverage plants, coffee and tea, provide the useful drug CAFFEINE ($C_8H_{10}N_4O_2$). Caffeine is extracted from the beans of the coffee plant. Its pure white crystals are prescribed by doctors as a stimulant to nerve activity. Often caffeine is mixed with aspirin and sedatives used for colds because it offsets their depressing action on heart and brain.

Certain plants of the nightshade-potato family (*Solanaceae*) give man two medicines: *atropine* and *belladonna*. These will slow the secretion of certain glands and will relax over-tense intestinal muscles. Atropine will enlarge the eye pupils so that the doctor can examine one's eyes.

People of old China, as in other old cultures, used many herbs now shown to be useless. But the ancient Chinese did use plants of the *ephedra* group which act like the modern animal gland extract adrenalin. The plant they called *ma huang* (*ephedra equisetina*) has the chemical *ephedrine* which helps people who have asthma.

The shiny-leaved, tiny wintergreen of the north woods has a medical use in addition to its value in flavoring. Wintergreen oil is

prescribed as a liniment rub for sore muscles. A cheap grade of liniment is now made from camphor (tree) extract.

Several medicines for heart diseases come from long known herbs. *Digitalis purpurea,* the common garden FOXGLOVE, was used by early peoples of Africa and the East Indies. Careful doses of digitalis extract speed up a weak, slow heart. By contrast, the drug *aconite* from leaves of monkshood will slow down the heart when it beats too fast, as during high fever.

All parts of castor oil plants, grown as garden oddities, contain both the poison *ricin* and also (in the castor beans) the skin lubricant and laxative, castor oil.

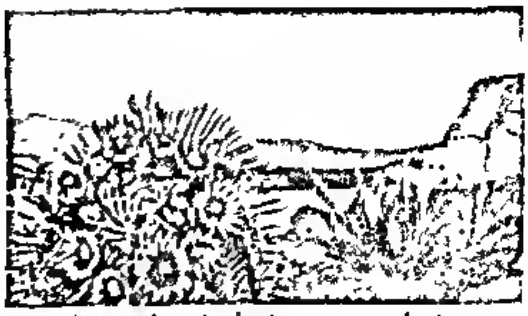
The two most widely grown narcotic-yielding plants are the Asian OPIUM poppy and the South American coca tree. The coca tree (*Erythroxylon coca*) is not to be confused with cacao trees (chocolate, cocoa) nor with cola trees (cola beverage). Poppy seed pods yield crude *opium* and *morphine;* coca leaves give *cocaine*. All NARCOTICS are dangerously habit-forming but are valuable in small, brief doses for severe pain.

Many other plants contain chemicals used in medicines. These include: juice of grapes, sugar cane, and beets (fermented to make medicinal alcohol); *henbane* and Jimson weed (drugs similar to belladonna); *cascara* leaves (laxatives); tanbark oak (tannic acid for skin burns); and several mint family plants (menthol, peppermint, etc. for tonics). D. A. B.

SEE ALSO: DRUGS, PHARMACOLOGY

Plants, succulent There are two main types of succulent plants. One kind is able to store water, like the *cactus* and *sedum* plants. The other kind is able to get along without water for a very long time, like the agave and yucca plants. Succulent plants get their name from the Latin word *succus,* meaning juice. Succulent plants can live in places too dry for other plants. They have many ways of protecting themselves from dry weather.

Succulent plants that store water have very fleshy leaves and stems, where they store water for use in dry periods. Succulents nearly all grow in regions of intense summer heat and dry weather. They are usually grown in desert gardens of the Southwest, in rock gardens, in garden areas lacking moisture, and in desert terrariums. They are more often grown for their interesting shapes than for their beauty. But some succulent plants have gorgeous flowers. The CENTURY PLANT flowers are prized because they are rare. Other unusual succulents are the stone plants, which look like living rocks. Lithrops are known as "window plants," because they have translucent leaves that lie flat on the ground. The leaves of haworthias are so close together that they form a solid column.



Many desert plants are succulents

Drought-resistant succulents have been known to survive for years without a single rainfall. M. R. L.

SEE ALSO: CACTUS, SEDUM, YUCCA

Plants, tropical Plants that grew originally in the regions near the equator are called *tropical* plants. They grow in deserts, on mountains, in jungles, grasslands, swamps, and forests. Tropical plants are common in the East and West Indies, Central and South America, Malaya, parts of Africa and Australia, and India. Tropical countries have a wet season and a dry season. Because there is no winter season, tropical plants grow during the entire year and grow large, dense, and in great variety. Many tropical plants are evergreen; others shed their leaves during the dry season, but new growth starts immediately.

EXPORT PLANT PRODUCTS

Man depends on tropical plants for food products, medicines, clothing,

The passion flower of tropical America

building materials. Pineapples, bananas, dates, coffee, bamboo, cocoa, tea, sugar, nuts, hemp, quinine, avocados, citrus fruits, cotton, coconuts, melons, beans, and hardwoods come from tropical plants.

Some tropical plants such as dieffenbachia, poinsettias, begonias, and cacti are raised as house plants in cold climates. Palms, rhododendrons, orchids, and ferns are often found in greenhouses and conservatories.

TROPICAL PLANTS IN THE GARDEN

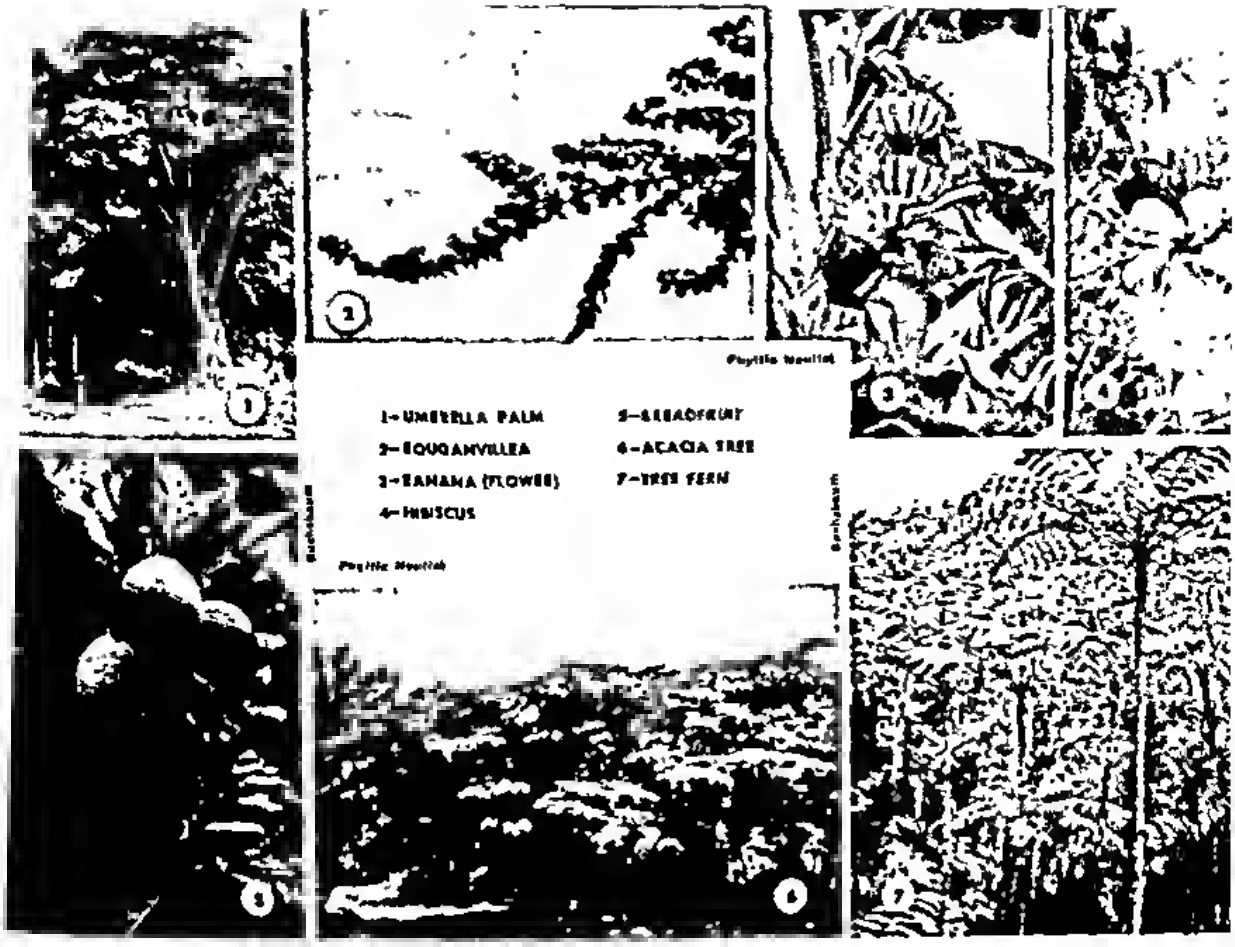
Many common garden plants which originated in the tropics have been adapted to temperate climates. *Cleome*, or SPIDER PLANT, has claw-like pink and white clusters of flowers that give the plant a spidery appearance. *Bleeding-heart* has red and white tubelike flowers that resemble small hearts. *Clematis* is a tropical vine that likes rich, moist soil and has many pink, purple, blue, white or yellow blossoms. *Lantana* shrubs are tropical plants with dense clusters of tiny flowers. The *oleander* has large clusters of red, pink, white, or purple flowers. The *canna* has bright, showy leaves and flowers. *Water lilies* and *lotus* plants have thick, fleshy stems, with air pockets that enable leaves and flowers to float. Most bloom during the day, but the Egyptian white lotus is an exotic night-blooming plant. The beautiful blue *Nympaea* lotus was revered by ancient Egyptians. The Hindus consider the Indian lotus a sacred plant. The largest water lilies, *Victoria Cruzianas*, are sturdy enough to support a small child.

TROPICAL FOOD PLANTS

There are many tropical food plants are so perishable, difficult to transport costly to market that they are seldom outside of the tropics. These foods are often mentioned in stories, poems, and songs. The tropical mango tree is well known for delicious fruit. Its leathery leaves on wide spreading branches make mangoes valuable as shade trees as well as fruit trees. Mango fruit is rich, sweet and spicy tasting. The oval, large, red-orange fruit is rich in vitamin A and C. *Breadfruit*, *jackfruit*, and *durian* are tropical fruits with rough spiny outer coverings. Breadfruit resembles a muskmelon. When cooked, it tastes something like a sweet potato. Jackfruit is a giant fruit that is sometimes two feet long and weighs up to forty pounds. Durian is a fruit with a characteristic strong odor. PAPAYA is a juicy melon-like fruit. This yellow fruit grows directly out of the tree trunk. The *soursop* is an evergreen tree bearing oval-shaped, green fruit. The tart, juicy flesh of the fruit is used in beverages and sherbet. The *sweetsop* is a deciduous tree. Its cone-shaped, eight-inch-long fruit tastes like sweet custard. The *passion fruit* grows on a vine called *passiflora*. The *passion flower* of tropical America is purple and white and about three inches wide. The markings of the flower resemble the cross used in the Crucifixion. This gives the plant its name. Natives of the tropics chew the *Betel* palm fruit. Their teeth are stained by the red fruit, but it is considered an aid to digestion. Roots of the *cassava* are eaten as starchy vegetables or ground into flour. *Tapioca* comes from cassava. *Yams* are *tubers* from a vine. Sometimes these tubers weigh more than forty pounds. YAMS are prepared like potatoes.

SOME ORNAMENTAL PLANTS

A beautiful tropical flower is the *bird of paradise*. The tall thin stalk and orange and blue flower head resemble a bird's neck and head. Stiff leaves, three to four feet long, are at the base of the plant. *Bougainvilleas* are vines belonging to the four-o-clock family. Their colorful modified leaves enclose small flowers. This adds to the size and beauty of the blossoms. Flowers are shades of purple, red, or gold, and bloom in long, waving sprays. The *wooden rose* vine grows like a morning-glory. The dried



seed pods it produces look like a rose carved from wood. These seed pods are used in dried flower arrangements. The *climbing pothos* vine is raised for its beautiful shiny leaves, that are sometimes two feet long. Air slots appear in the sides of the larger leaves, allowing wind to pass through the vine without damage. This vine grows on palm trees for support. Its weight often kills the tree. *Frangipani* or *temple* tree is a deciduous tree about thirty-five feet tall. The tree flowers before the leaves appear and continuously thereafter. Fragrant yellow, white, or red clusters of flowers are at the ends of the stiff, blunt branches. Frangipani flowers are used in making Hawaiian leis. In Ceylon and India these trees are planted in temple gardens. The *African tulip* tree or *Spathodea*, is a fifty-foot, evergreen tree Throughout the year red flowers, shaped like cups, bloom on the ends of the high branches. The *traveler's-tree* has leaves that resemble banana tree leaves. They are arranged like parts of a giant fan, up to forty feet tall. Rain water collects at the base of the leaf stalks, and water can be obtained by cutting into these stalks. The EUCALYPTUS is sometimes called the *stringy-bark* or *gum* tree. These evergreen trees grow rapidly up to three hundred feet tall. *Acacias* are shrubs or trees. Their flowers are yellow or white and grow in fluffy clusters. The national flower of Australia is the *wattle*, an acacia.

OTHER UNUSUAL PLANTS

Giant flowers are found among *Rafflesia* plants. The tubers of this plant weigh over one hundred pounds The plant is a PARASITE which attaches itself to ground vines. The flowers may be three feet wide and as tall as a man They give off an unpleasant odor to attract carrion flies. *Krubi* is a giant flower that grows up to eight feet tall and has a disagreeable odor *Mangrove* trees grow in salt water swamps and support themselves with prop roots. These roots grow down from the trunk and branches. Many of the wild FIG and EBONY trees produce fruit and flowers on their trunks and branches.

The tree fern is a true fern which grows to 60 feet tall. It is similar to coal age ferns and thus is termed a "living fossil." M. R. L.

SEE ALSO: GEOLOGIC TIME TABLE

Plasma see Blood

Plasma membrane see Cell

Plaster Plaster is a hard material that is coated on walls and ceilings inside buildings. Plaster comes as a powder of cementing chemicals and fine sand.

Different plaster powders contain various amounts of unslaked lime, GYPSUM, and Portland cement. Hair or fibers are also included in the powder mix in order to give strength to the finished plaster coat.

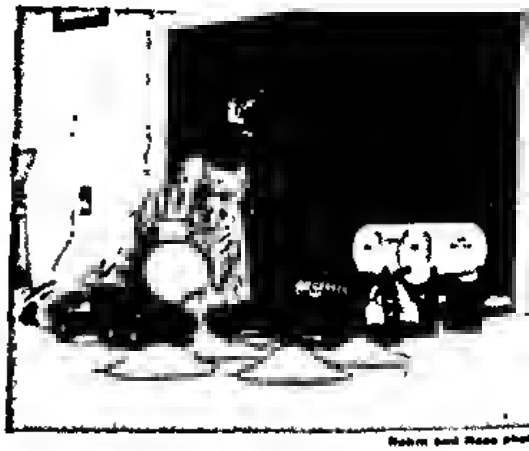
When a plastering job is started the dry plaster powder and sand are mixed with water. The thick, creamy mixture is quickly applied to the *lath* or other plaster base. Plaster bases are the rough surfaces of walls and ceilings. They may be made of concrete blocks, hollow tile, brick, gypsum board or lath. Lath consists of strips of wood or steel having air spaces between strips. The soft, fresh plaster works into such spaces and thus helps keep the dried plaster clinging to the surface.

When mixes of plaster are used for outdoor wall coatings, they are called *stucco*. For smoothly finished, indoor surfaces, a second coat of fine, sandless lime plaster is put onto the first, or rough, undercoat.

Plasterboard is machine-made wall covering. It consists of pairs of sheets of heavy paper or fiberboard containing a sandwich-like filling of gypsum plaster D A B

SEE ALSO CEMENT

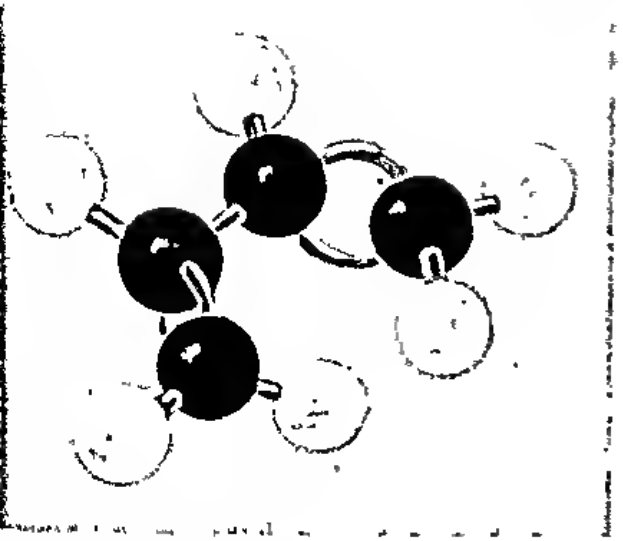
Plaster of Paris When gypsum is



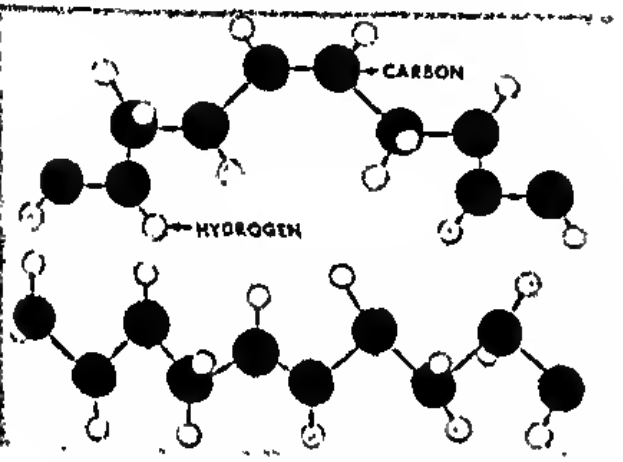
High impact plastic toys resist breakage

Plastics Plastics are organic material made by man which can be shaped by heat or pressure, or both. Plastics are used for brush handles and bristles, toys, transparent wrappings, fountain pens, insulators, costume jewelry, dishes, and many other items. Some day they may be used in place of metals in the building of houses, automobiles, and airplanes.

Plastics are either *thermoplastic* or *thermosetting*. Celluloid, which was discovered about 1869 by John W. Hyatt, is thermoplastic—it can be softened again and again by high temperatures and remolded. Bakelite, discovered by Leo H. Baekeland about 1907 is thermosetting—once formed, it becomes insoluble and cannot be remelted

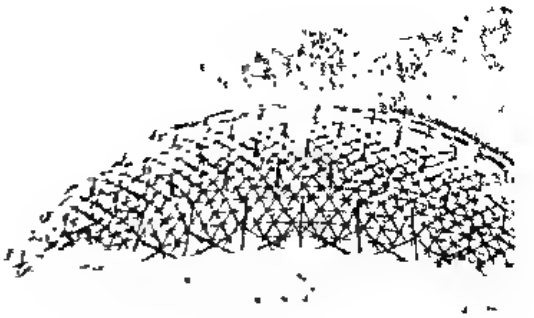


Structure and uses of one basic plastic chemical, butadiene with formula C_4H_6



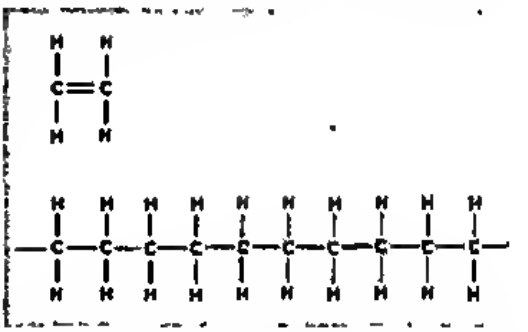
Polybutadienes, or butadiene plastic polymers: the molecules can join together, or polymerize, in different ways. The plastic in the upper figure is rubbery; the lower one is fibrous

In this example of polymerization (right), the original molecule is ethylene, a gas. The linear chain is a polyethylene plastic



Bohm and Haas photo

The Climatron at the Missouri Botanical Garden has a roof, or protective "skin," of acrylic plastic



heat and a catalyst The high polymers are of particular importance. High polymers include textile fibers, rubber, protein, starch, wood, hormones, and, of course, plastics and resins.

The most important polymers fall into two basic groups: *long-chain* and *cross-linked* Two familiar chain polymers are STARCH and CELLULOSE. The building blocks of these chains are units of sugar molecules, *glucose*. They differ only in the way the sugar links are joined. The effect is that man can digest starch but not cellulose. Cattle and goats can digest both. Thus, there is available food in potatoes, but not in the bark of a tree. By vulcanizing rubber (reacting raw rubber with sulfur at high temperatures), one gets a cross-linked polymer. The cross links serve to strengthen the rubber.

When *ethylene*, as a liquid, is heated under a very high pressure with small amounts of oxygen, many molecules combine to form the product *polyethylene*. Polyethylene is of great commercial importance. It is a tough solid which has valuable insulating properties and is little affected by most chemical reagents and solvents. It is used as a protective coating and for making containers.

Similar molecules, called *vinyls*, polymerize to become useful as insulating materials, garden hoses, and packaging as in the transparent trade product, *Saran*.

PHENOLIC OR FORMALDEHYDE RESINS

Resins, organic substances from

SOME PLASTICS AND THEIR USES

THERMOSETTING (hardened by heat)

Method of obtaining: Condensation polymers (adjacent molecules join by splitting off water)

COMPOSITION	RAW MATERIALS	SOME USES AND CHARACTERISTICS
Phenol-formaldehyde (Bakelite, Textolite)	air, coal, water, oat hulls, fillers	utensil handles, bottle caps, small boxes, plywood adhesives
Urea-formaldehyde	air, coal, water, limestone, fillers	small cases, buttons (plastic has extreme toughness; also can be made in bright colors)
Melamine-formaldehyde (Melmac)	coal, water, limestone, fillers	dishes, electric appliance covers, adhesives, fabric surface (can be made in bright colors)

THERMOPLASTIC (soften when heated)

Method of obtaining: Additional polymers (as in illustration on page 1333)

COMPOSITION	SOME USES AND CHARACTERISTICS
Alkyd resins	protective coatings (paints, etc.)
Casein	costume jewelry, buttons, adhesives
Cellulose nitrates, Cellulose acetates	plastic rods, wrappings, film
Ethyl cellulose	auto *hardware, moldings, electrical insulation*
Polystyrene	toys, boxes, novelties (water resistant)
Methacrylate	dental plates, optical lenses, rods and tubes (has optical properties)
Polyvinyl acetates, Chlorides	shower curtains, drapes, garden hose
Super-polyamides (Nylon, etc.)	bearings, gears, bristles, fabrics
Trichloro-fluoro-ethylene	tubing, electrical insulation
Polyethylene	film, insulation, freezer bags
Polyvinylidene chloride (Saran)	sheets, tubes, molded products (resists solvents)

plants, are among the earliest synthetic plastics. Their commercial development was a realization of the efforts of the American chemist, Leo H. Baekeland, who studied the properties of these plastics around 1910. These resins were known as *Bakelite*. The terms "resin" and "plastic" are often used interchangeably. In more careful use, resin refers to the polymer and plastic to the product obtained from the resin by incorporating plasticizers, fillers and, if desired, dyes.

Continuous heating of a phenolic resin creates larger and larger chains. The polymerized product becomes firmer and firmer. *Wood pulp and other fillers with coloring* matter are added to this powder and further heated in molds to give the final product. Some of these resins are water soluble. They are mixed with textiles, and with further heating, the polymerization continues, resulting in water repellent fabrics such as the popular "*drip-dry*" *materials*.

A polymerization reaction does not continue indefinitely. Actually, as the molecular weight increases the activity decreases so that there is a practical limit to the size of a polymer molecule.

GLYPTALS

Polymers prepared from *glycerol* and *phthalic* acid are known as *glyptals*. They have cross-linking which makes them useful in the synthetic enamels for finishes on automobiles and household appliances.

FOAMED PLASTICS

These materials, which are porous *and* of low density, are valuable for insulation, for cushioning, and for structural materials. They can be made by dispersing a gas evenly throughout a resin before it is set. When the resin is set, the gas expands and is entrapped in pores, or escapes leaving pores. Two important foamed plastics *are styrofoam* and *urethane*.

ION EXCHANGE RESINS

When special chemical groups are attached to phenol-formaldehyde resins, they are useful as water *softeners. The ions which cause the water to be "hard" are exchanged for sodium ions. The resin is regenerated by treatment with sodium chloride.*

J. F. S.

SEE ALSO: ORGANIC COMPOUNDS, RESIN, SYNTHETIC FABRICS

Cell of potato tuber. Leucoplasts enclose the developing starch

Spirogyra, a green alga. "A" is the chloroplast

Plastid (PLASS-tidd) There are small bodies in plant cells that are made of colored material. They are named *plastids*. The CHLOROPHYLL in plastids makes the leaves green. A carrot has orange plastids, and a beet has red ones. The plastids in a white potato have no color. The plastids help a plant to make food or to store it for use later.

Plastids are formed from the cytoplasm in the cell or from the division of other plastids. Usually plastids have a definite shape and are the center of a special chemical action. *Chloroplastids* (*chloros*—green) make carbohydrates from carbon dioxide, water, and light. Chlorophyll is always contained in plastids, except in the plastids of blue-green algae and photosynthetic bacteria. *Chromoplastids* (*chromos*—color) may contain two chemicals—XANTHOPHYLL and carotenes—which gives the yellow color to many fruits, vegetables, and autumn leaves. *Leucoplastids* are colorless and contain starch.

H. J. C.

Plateau (platt-TOH) A plateau is an elevated flat area. Plateaus may be a few hundred feet high or thousands of feet high. In most cases they are distinctly above the surrounding lands, but some are flat lands surrounded by mountains.

Some plateaus are small, but most are hundreds of square miles in area.

Plateaus developed from up
earth's surface when mountain
formed from lava flows and
of the surface which left one po
Most plateaus are worn and gr
giving the appearance of being
region. A dramatic example of
work on a plateau is the Gran
formed in the Colorado Plateau of
The greatest plateau, however, is
Tibet.

SEE ALSO: GEOLOGY, MESA, NORTH

Platelets see Blood, Circulato
tem

Platinum (PLATT-in-nuhm)
num is a grayish-white metallic
ment more precious than gold. It r
at the high temperature of 1770° C
tigrade. It is heavy and malleable
can be drawn into a fine wire and ha
mered into thin sheets. It does not o
dize in air, which means that it will n
tarnish. It is resistant to heat and mo
chemical reagents but dissolves i
aqua regia. It is corroded by chlorine,
sulfur, and caustic alkalis. It combines
readily with most metals. Its atomic
number is 78 and it has an atomic
weight of 195.23. The symbol for
platinum is Pt.

Platinum is easily welded and therefore
valuable in the manufacture of delicate lab-
oratory and surgical instruments and var-
ious electrical apparatus.

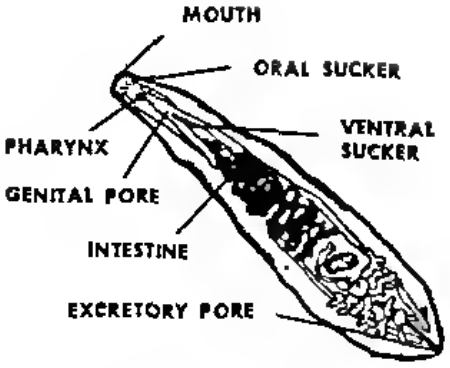
The chemical industry uses containers
made of platinum because they are resistant
to heat and chemical reagents. Platinum is
in demand by jewelers. It is used for set-
tings for valuable stones and is very adapt-
able to fine and delicate engraving. The
finest fountain pen points are made of plat-
inum.

A platinous compound is used in photog-
raphy. It is used to make fluorescent screens
for X-rays.

Platinum is found principally in the Ural
Mountains of Russia, Colombia, South
America, Canada, and Oregon, California,
and Nevada in the United States.

SEE ALSO: ELEMENTS

W. J. K.



Liver fluke, a typical flatworm

Platyhelminthes (platt-ee-hell-MINN-theez) Platyhelminthes are animals better known as *flatworms*. With their wide, thin bodies, they look like pieces of ribbon. Some of the ocean flatworms are shaped like tree leaves. They have beautiful, striped bodies with ruffled edges.

The smallest flatworm cannot be seen except under a microscope. Some live under stones on the damp forest floor. Others cling to plants and rocks in ponds and oceans. Most of the largest, like the fluke and tapeworm, live hidden in the bodies of animals where they cause disease.

Movement from place to place is slow. Most flatworms propel themselves by beating rows of tiny *cilia*, which cover their bodies. Many secrete a carpet of *mucus*, over which they glide. Muscles help them to wriggle and squirm, and to change position. Obtaining food is difficult for a slow-moving worm. Since food is plentiful in the body of other animals, many flatworms have adopted a parasitic way of life.

The free-living flatworms are a busy, active group, found in water and on land. Most of them are *carnivores* which feed upon tiny animals. They often work slowly upon a dead animal or upon an oyster or barnacle, which cannot run away. While a few members have no DIGESTIVE SYSTEM, others have a simple digestive cavity, shaped like a glove, with three or more branching pockets. Since there is only one opening to the digestive cavity, food enters and waste is eliminated through the mouth.

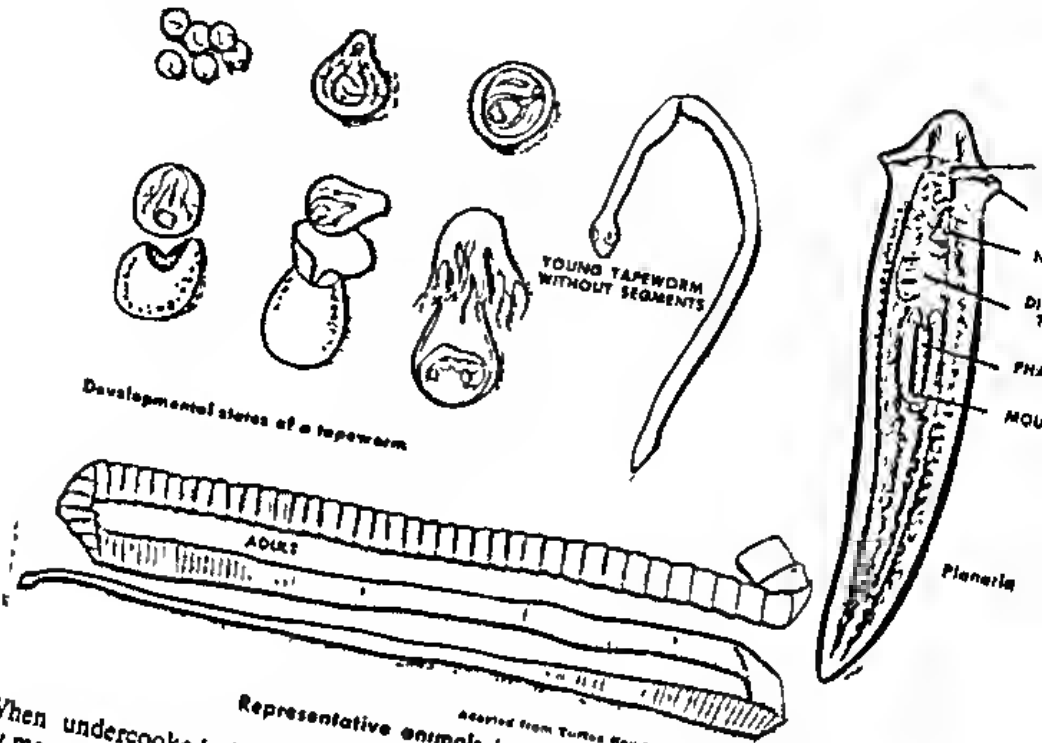
The fresh-water *planaria* is perhaps the best known member of this group. The mouth is located on the bottom of the body at the end of a muscular pharynx. The animal feeds by pushing the *pharynx* or muscular, tongue-like organ outside the body cavity. Food, taken directly into the pharynx, is crushed into smaller pieces. The PLANARIA has a well-developed head with two clusters of eyes and two sensory areas on either side of the head. Planarias have great powers of regeneration. Almost any medium-sized piece will grow into a complete worm. If the head is cut down the middle, the planaria will grow two new heads.

Just as all animals must adapt to a new environment, the body of the parasitic flatworm is modified, in order that it may live inside another animal. The adult attaches itself tenaciously to the body of its host by means of suckers or sharp hooks. Since the adult no longer needs to move in search of food, it loses its outer covering of cilia, which is replaced by a thin protective cuticle. The TAPEWORM which absorbs its food directly through the body wall from its host, has neither a mouth nor a digestive system.

A few of the PARASITES spend their lives in the body of only one animal. Some *flukes are external parasites*, which live on the skin or gills of fish. Other one-host flukes are internal parasites which enter the host through openings like the mouth, anus, or *excretory pore*. Many are found living inside fish, amphibians, and aquatic reptiles.

Most parasitic flatworms have a complicated life history. In order to develop from egg to larva, and finally to adult form, they need to find two or more hosts in whose bodies they may pass through various stages. This is called *alternation of hosts*.

Adults of both the fluke and tapeworm usually develop in the bodies of vertebrates such as man, fish, cow, or mouse. The fluke LARVA, which passes through four larval stages, generally develops in the body of a small invertebrate animal, like the snail or copepod. The Chinese LIVER FLUKE, for example, passes through four larval stages in the body of a particular species of snail. The larva swims to the body of a fish and finally enters a human host, when raw fish is eaten by man. The tapeworm usually needs two vertebrate hosts. The larva of the beef tapeworm develops in the cow



Representative animals in the phylum Platyhelminthes

adapted from Turtox Key card 8 8 courtesy General Biological Supply House Ch

When undercooked diseased beef is eaten by man, the tapeworm matures in the human intestine.

While flatworms are primitive animals, they are the first phylum in the history of life to show "two-sided" or *bilateral symmetry*. Flatworms have three body layers The outer layer of adult parasites is often only a thick cuticle, but the free-living flatworms have a ciliated epidermis The middle layer, or *mesoderm*, is a solid layer, containing muscles, as well as excretory and reproductive organs While some of the free-living flatworms have well-developed nervous systems, many parasites, like the tapeworm, have only a few sensory cells around suckers. No special circulatory or breathing systems are present

Most flatworms produce both eggs and sperm Flukes and tapeworms are very specialized for the business of reproduction Their reproductive systems are more complex than those of any higher animal To assure reproduction of the species, these animals produce thousands of eggs, because many eggs do not find a suitable host and die.

E. P. L

SEE ALSO: ANIMALS, CLASSIFICATION OF

Platypus see Duckbill

Pleiades see Taurus

Pleistocene see Cenozoic Era, Geologic time table

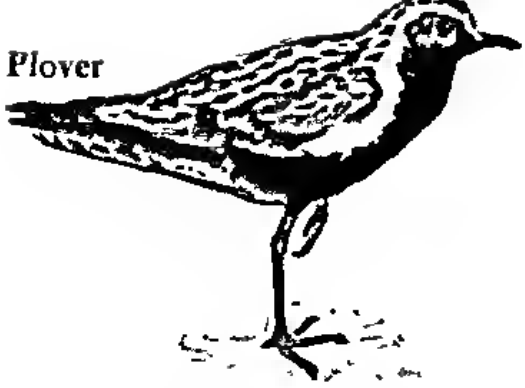
Pleurisy (PLOOR-uh-see) Pleurisy is an inflammatory disease of the *pleura* The pleura is the serous membrane that lines the chest cavity, and each lung has a separate pleura. Pleurisy is generally caused by a cold, or by another disease such as cancer, pneumonia, or tuberculosis.

The symptoms of pleurisy are a dry cough and sharp pain Rasping sounds may be heard in the chest Breathing becomes difficult, resulting in short gasps There is weakness, headache, a rapid pulse, and loss of appetite Pus in the pleural cavity is very dangerous and is indicated by chills, fever, and a changing temperature Rest and inactivity are required for relief Antibiotics may be prescribed as medication

M. R. L

Plexus see Nervous system

Pliocene see Cenozoic Era, Geologic time table



Plover

Plover Plovers are a family of birds. There are many different species, or kinds, of plovers. All of the plovers are shore-birds. They live near water and are generally wading birds.

Plovers usually have short bodies and short, thick necks. Their legs are rather long so they can wade in shallow water. Most types of plovers have three toes.

Plovers make their nests on the ground. Almost always the females lay four spotted eggs that look like pebbles.

Plovers migrate great distances. Some plovers spend the summer on the Arctic shores and fly to the Hawaiian islands or Central or South America during the cold winter weather. The *lapwing* is a beautiful European plover. C. L. K.

Plum A plum tree has smooth-skinned, juicy, tart fruit. The plum is often dried to make prunes. In the United States, plums for prunes are grown in the Pacific states, where drying conditions are most favorable.

Plums are shrubs, or small trees, with white flowers, and large, smooth, clustered fruits. When dried for prunes they must be fully ripe.

Plum trees are usually bought as one-year-old trees and are planted in the fall, or early spring, in the colder climates. Plums need heavy, well-drained soil. The young trees must be pruned to shape and to develop better quality fruit.

The European plum is the most important type in the United States. The Japanese plum includes most of the varieties produced on the west coast for the fresh fruit market. Native American varieties are quite desirable in their own areas and are good in home orchards. M. R. L.

Plum tree with ripe fruit

Plumeria

Plumeria (ploom-AIR-ee-uh) The plumeria is also called the *frangipani* or *temple* tree. It is a small tree or shrub that grows only in tropical areas. It is well known for its beautiful and fragrant flowers. The large waxy flowers are funnel-shaped and can be white, pink, red, or purple. This flower is frequently used in making Hawaiian wreaths or leis. It is also used in making perfume.

Plumeria belongs to the *dogbane* family, and so is related to the oleander and periwinkle. The most common plant is the *Plumeria rubra*, which attains the height of fifteen feet. The fruit of the plumeria consists of leathery pods. Leaves are oblong, about four inches wide, and can be twelve to sixteen inches long. J. A. D.

Plumule The plumule is the terminal bud at the end of the *hypocotyl* (embryonic stem) above the cotyledons in the seed of a plant. It is a shoot having two distinct leaves.

Pluto has an eccentric orbit, part of which lies within the orbit of Neptune

Pluto Pluto is the ninth planet away from the sun. It was discovered in 1930. No planets beyond Pluto are known to exist. Pluto is thought to be one of the smallest planets. It is probably very dense. It does not seem to have a thick atmosphere as the gas giants do. Its path is not on the same level as the other planets. The orbit of Pluto is a long and drawn out ellipse (oval). The sun is not exactly at the center of Pluto's orbit.

Pluto does not seem to be very much like any of the other planets. The four inner planets are called *terrestrial* or "earth-like" planets. The next four are the *gas giants*. Because it is small and dense, Pluto is put in the group of terrestrial planets.

After Uranus and Neptune were discovered, astronomers thought that they had solved the mystery of the changes in Uranus' motion They found, though, that Uranus was still not moving according to predictions. They wondered if perhaps there might be still another planet beyond Neptune. Early in the 1900's, an American astronomer Percival Lowell worked out by mathematics some approximate figures for "Planet X." Lowell's description of the planet that no one had ever seen turned out to be remarkably close to what was later discovered to be true. Although Percival Lowell looked for Planet X for several years, he never found it. He died in 1916. Other astronomers took on the search. In 1930 Clyde W. Tombaugh found the mystery planet. He used Lowell's figures and took pictures of the area of the sky that supposedly would show the planet. Pictures taken on different nights showed an object that looked like a faint star. But this "star" was in a different position on different nights. It was moving. It was the new planet.

Even through very powerful telescopes, Pluto only shows itself as a tiny point of light. It is difficult for astronomers to get much accurate information about this tiny speck of light What is more, astronomers are not at all sure that Pluto is even what it seems to be. The point of light that they are studying could be only a small reflecting patch on the surface of a much larger planet

There is very little reliable information about Pluto. It seems to be a planet that is smaller than Earth Its diameter is estimated to be about 3600 miles, but it could be as small as the moon or it could be about the size of Mercury Because it influences the motion of other planets, astronomers think that Pluto must be very dense. Its average distance from the sun is over 3½ billion miles. Its temperature is probably nearly 400 degrees below zero Fahrenheit. From Pluto the sun would look like a very faint star

It takes Pluto about 248 years to make a trip around the sun. Pluto's orbit is not circular; it is elliptical. The sun is not at the focus of the ellipse When Pluto is at its closest point to the sun, Pluto is actually inside of Neptune's orbit. Then Pluto is nearer to Earth and the sun than Neptune is. From 1968 to 2009 Pluto will be nearer to Earth than Neptune. Then astronomers will be able to get a closer look, and they may find out more about Pluto.

All of the other planets revolve around the sun in about the same plane or level. Some of the other orbits are slightly tilted, but Pluto's orbit is inclined at a sharp angle of 17 degrees. This means that sometimes Pluto is high above the other planets in their journey around the sun and sometimes Pluto is rather far below the others.

Because it is difficult to see Pluto's disk, astronomers find it difficult to determine Pluto's period of rotation. It is thought that Pluto rotates in about 6½ days. Astronomers have not been able to discover any satellites of Pluto.

Some theories have suggested that Pluto

is not a planet at all. It could be a burned-out star that used to make the sun a double star. Or Pluto could have been a moon that used to revolve around one of the large planets but went astray and was trapped in an orbit around the sun by the sun's gravity. The difference between Pluto and the other planets lead some astronomers to suppose that Pluto's origin was different from the origin of the other planets. C. L. K.

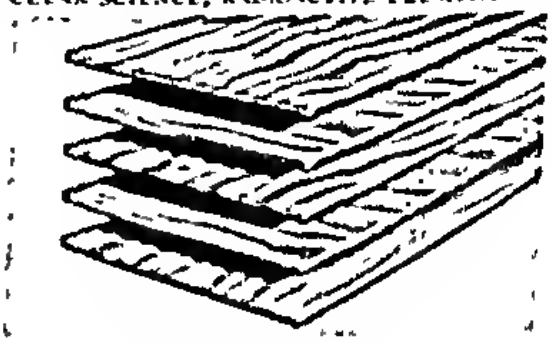
SEE ALSO: NEPTUNE, URANUS, SOLAR SYSTEM

Plutonium (ploo-TOH-nee-um) Plutonium is the 94th element. It was discovered in 1940 by GLENN SEABORG. In its pure form it is a silvery-white metal and has chemical properties like those of TUNGSTEN.

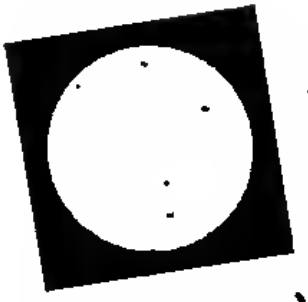
Plutonium is found in the uranium ore PITCHBLENDE in extremely small amounts. Man-made plutonium was first produced, however, by bombarding (Pu^{239}) as it uses up another nuclear fuel (U^{235}) is called a *breeder* reactor. The plutonium produced can be separated from uranium by chemical methods. But the separation of the rare U^{235} from the abundant U^{238} is more difficult because these materials are chemically identical.

As with other metals, salts of plutonium are known and have been produced in the laboratory. Among these compounds are the oxides, halides (chlorides, bromides and iodides), and carbides. M. S.

SEE ALSO: ATOM, BOMBS, ELEMENTS, NUCLEAR SCIENCE, RADIOACTIVE ELEMENTS



Lamination of plywood



Pneumonia bacteria, magnified about 2000 times

Pneumonia (nyoo-MOH-nee-uh) Pneumonia is a disease that affects the lungs and causes hard coughing, high fever, chest pain, and difficult breathing. There are several kinds of pneumonia and many causes for it.

With *lobar* pneumonia an entire lobe of the lung is inflamed. In *lobular* pneumonia only parts of the lobe are involved. With *bronchial* pneumonia the bronchi are infected.

Pneumonia may be caused by a VIRUS, or by various types of BACTERIA, the most common of which is the *Pneumococcus*. The breathing in of gases and chemicals can cause forms of the disease. Oil in the lungs causes *lipoid* pneumonia. Such diseases as *tuberculosis*, *bubonic plague*, or *tularemia* may involve varieties of pneumonia.

Reddish-brown *phlegm* and difficult breathing with chills, fever, and hard cough signal the onset of pneumonia. It may follow *measles*, *influenza*, *bronchitis*, or other illness, or it may appear suddenly with no preliminary illness.

The disease usually lasts about a week; the crisis usually occurs when the patient seems most ill. Then abruptly, in responsive cases, the high fever falls, breathing becomes easier, and recovery begins.

The best protection against pneumonia is a healthy body to ward off INFECTION. Proper care during and following illness includes bed rest, prompt administration of antibiotics, and care during convalescence. Poorly-ventilated, overheated rooms and crowds in raw, wet seasons may foster pneumonias as they do the common cold.

Treatment depends upon the type of pneumonia. *Penicillin*, *streptomycin*, and *sulfa* drugs combat bacterial types but do not affect the viral types.

In pneumonias caused by TUBERC rheumatic fever and other systemic d the offending disease should first be Likewise, treatment of noninfectiv monias with chemical, allergic, or causes should begin with remov causative factor In pneumonias, frequently administered to aid r Infective varieties may be conta therefore, quarantine measures scribed. Animals, too, are sus pneumonia.

SEE ALSO LUNGS, RESPIRATORY

Poi see Taro

Poinciana One of the m sights in the southern sec United States and in the is the brilliant poinciana tive of Madagascar, flowering tree adds a bri to the landscape during mer season of bloom.

The scarlet poinciana clusters, each blossom me four inches across. There spread petals, one strea Ten long stamens grow o The tree bears fruit po feet or more in length ar wide. The purplish-bro hard, oblong beans. Kno *cock flower*, the poinci of 20 to 30 feet. This year long because of which provide a lacy,

Poinciana tree or

White poinsettias

Poinsettia (poyn-SETT-ee-uh) In the northern parts of the United States, the poinsettia is a Christmas-time plant. It is grown in greenhouses and used as decorations in homes and churches. In the southern states poinsettias grow in gardens. Originally, the poinsettia came from Central America and Mexico and was brought to the United States by Dr. Poinsett of Charleston, South Carolina, for whom it was named.

Poinsettias grow from two to six feet high and have clusters of tiny yellow flowers surrounded by a brilliant red rosette of *bracts*. Recently, white and pale pink poinsettias have been developed. The green leaves grow rather sparsely on slender, smooth, sometimes crooked stems. Growing outdoors, or inside in a pot, the poinsettia likes shade and moisture. J. K. K.

Poison Any substance which, when taken into the body, affects health or causes death is a poison. Poisons are very common. Every household contains poisonous items such as ammonia, medicines, and kerosene. Chemical warfare utilizes poisonous gases. Many classical stories and dramas refer to one or another poison.

Poisons are classified according to the bodily part affected. Most poisons, if used in proper quantities or for the original purpose, are of great help to mankind.

A large group of poisons are called *nerve poisons* because of the effect on the nervous system of the body. Among nerve poisons are *strychnine*, *chloroform*, *alcohol*, and *belladonna*. These poisons cause delirium, convulsions, and stupors.

Irritant poisons are caustic poisons caused by *acids*, *alkalies*, and mercurie and phosphorus compounds. The irritant poison taken into the body burns the throat, the passage to the stomach, and the intestine.

Poison gases are used in wartime or are sometimes released in an industrial accident. These gases can stop the action of the heart or eliminate the oxygen supply to the body.

Numerous poisons are found around the house. Many household cleaners such as ammonia, lye, turpentine, and kerosene, if taken by mouth, are poisonous. Extremely dangerous are the very common INSECTICIDES If food is neither prepared nor refrigerated properly, food poisoning may occur. Medicines are often taken in too large dosages or by mistake. Most medicines, if not taken as directed, will cause serious illness or death. The type of deadly mushroom called the *death cup* may be eaten by unsuspecting people. Most poisons have a known *antidote* which, if given promptly, will offset the effects of the poison.

The American Red Cross, the National Safety Council, Scout organizations, as well as many other medical and civic organizations, sustain a continuous campaign to prevent accidental poisoning.

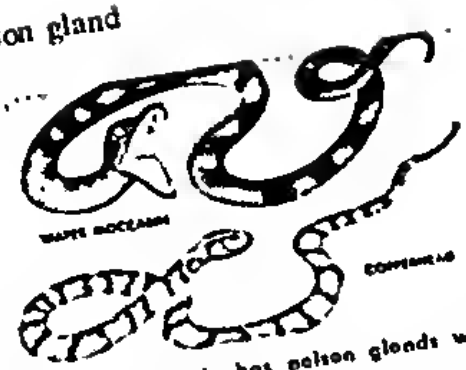
Fundamentally important to remember is the prevention of accidental poisoning. Several safety rules are: (1) keep all household cleaners, insecticides, and medicines out of the reach of small children; (2) poisonous medicine and drugs, labeled with a skull and crossbones, should be locked up; (3) older children should be trained as to the dangers of poisons; (4) all unnecessary poisonous items should be thrown away; (5) the family should know the first-aid treatment for poisons. P. F. D.

SEE ALSO: ANTIDOTE, ARSENIC, CHEMICAL WARFARE, FIRST AID

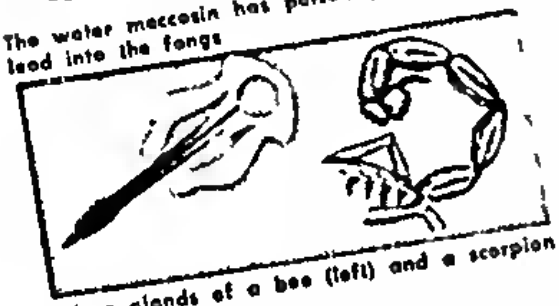
UNIVERSAL ANTIDOTE

Two parts—burned toast, powdered
One part—milk of magnesia
One part—strong brewed tea

The burned toast supplies absorbent carbon, the milk of magnesia is mildly alkaline buffer and the strong tea has tannic acid that neutralizes acids. For emergency only



The water moccasin has poison glands which lead into the fangs



Poison glands of a bee (left) and a scorpion (right)

Poison gland A poison gland is a specialized gland found in some animals. This gland produces *venom*. Poison glands are used for protection or as a means of getting food. Venom may cause pain, dizziness, swelling, paralysis, or even death of the victim.

Among animals that have poison glands are some SNAKES. Their fangs contain saliva that can poison other animals when it is injected into the blood stream. Scorpions kill their prey with a poison stinger at the end of their tail. Toads have small poison glands in their skins The GILA MONSTER bites, and venom flows from glands in its lower jaw into the wound. BEES, wasps, and hornets are well-known for their effective stingers. The sting ray lies on the ocean or river bottom and with its tail drives a sharp spine and poison into its enemy. The Portuguese man-of-war floats like a balloon and has tentacles with stinging cells, reaching down underneath. Some tropical catfish have poison glands in their spines. M. R. L.

Poison ivy Everyone should know what poison ivy looks like in order to avoid it. The tissues of this plant contain a poisonous oil which causes fever and itching, burning and blistering of the skin.

A low shrub, poison ivy climbs trunk trees and stone walls or crawls over ground Sometimes it grows like a The shiny, green leaves are compos three leaflets They turn red in the au Early in the season, tiny greenish bl of flowers are attached to the main They are followed by clusters of poi yellowish berry-like drupes If the from poison ivy get on the skin, t should be washed several times wit yellow laundry soap and hot water

SEE ALSO POISON OAK

Poison oak

Poison oak The leaves oak plant looks much the poison ivy except on the edges. They co three leaflets, are lig but lighter underneat ly covered with fine

One form of poison the Pacific Coast of shrub about eight feet variety found in the s

Contact with poiso same itching and blis poison ivy, and requir The skin should be s and alkaline soap imm

Poison sumac see

Pokeweed see W

Polar bear see B

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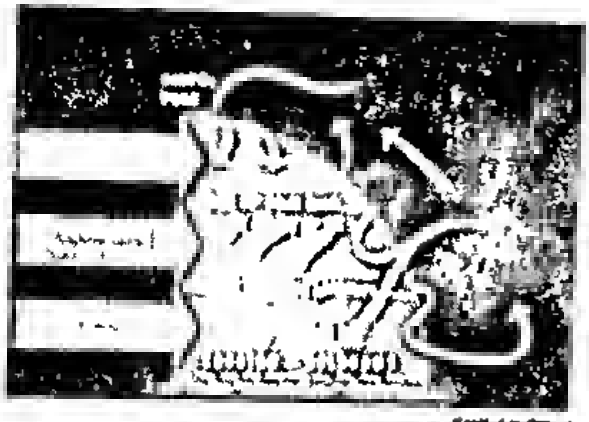


The polar easterlies meet the prevailing westerly winds at approximately latitude 60°

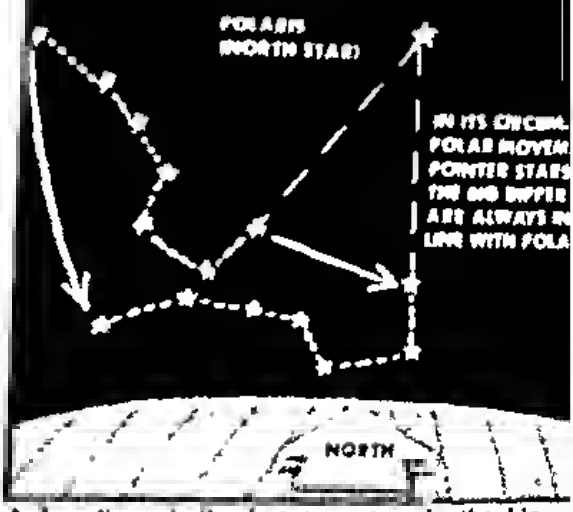
Polar easterlies The heating and cooling of the earth's surface, plus the rotating movement of the earth upon its axis, causes massive movements of air. Scientists have observed and recorded information about the air movements, and classified them into what is called the *planetary wind system*. The *polar easterlies* are part of that system of winds which are characteristic of the polar regions near the North and South poles.

Weather in the middle latitudes, where most people live, is greatly affected by the polar winds. Their extreme force and cold cause many hardships for men attempting to explore the polar regions. When the pressure is sufficient, great air waves break out of the polar zones and reach far into the middle latitudes. As they travel toward the equator, they are deflected to the west in the Northern Hemisphere. At some point they interact with the *prevailing westerlies* on their way east. This impact is sufficient to cause *cyclonic* storms. When large bodies of polar air are caught in the westerlies and carried eastward, they become traveling *anticyclones*, or highs. E. M. N.

SEE ALSO: WEATHER, WESTERLIES

Polar regions see Antarctica, Arctica, Earth

Polaris (poh-LAIR-iss) Polaris is the star that is always almost directly above the North Pole. It is also called the *Pole Star*. For many years sailors and explorers in the Northern Hemisphere have used this star to find directions. When a person faces Polaris, he is facing true north. Polaris is sometimes called the North Star.



A line through the last two stars in the big dipper will point directly at Polaris

Polaris is not one of the brightest stars in the sky. It can be found easily, however, with the help of the "pointer stars." The pointers are two stars in the Big Dipper that point to Polaris. They are the two stars that form the side of the dipper which is farthest from the handle. A line through these two stars leads to Polaris. Polaris is the last star in the handle of the Little Dipper. The dippers are parts of the constellation *Ursa Major* and *Ursa Minor*.

Polaris cannot be seen at all in the Southern Hemisphere. In the Northern Hemisphere it is visible the year round. Polaris is not exactly above the North Pole. If it were, it would not seem to move at all. As the earth rotates, however, Polaris traces a very small circle around the celestial North Pole. The constellations near Polaris are called *circumpolar constellations*. They seem to move in a circle around Polaris.

Besides helping to find directions, Polaris can tell a person in the Northern Hemisphere what latitude he is in. The degree of the angle from the horizon to Polaris is about the same degree of latitude that the observer is from the equator. At the equator this angle is zero for Polaris is on the horizon. At the North Pole, the angle is 90 degrees. Polaris is directly overhead.

Polaris has not always been the pole star. Many years ago, *Thuban* was the star used to find the north direction. The earth's axis changes its direction very slowly. It is moving away from Polaris now. In about 12,000 years *Vega*, a very bright star, will be the north star. C. L. K.

SEE ALSO: BIG AND LITTLE DIPPERS, CONSTELLATION, URSA MAJOR AND MINOR

Polaris see Missile, Submarine

arization

larization (poh-ler-uh-ZAY-shun) hen the *electrodes* in a *voltaic cell* any other cell become surrounded y atoms of nonconducting gases, the nternal resistance of the cell in- creases. The result of the increased internal resistance is a drop in the emf (electromotive force) of the cell. This decreased emf is due to *polariza- tion* of the electrodes.

The process of polarization in a voltaic cell is somewhat as follows: The electrodes of the cell, in which the CATHODE is copper and the ANODE is zinc, are placed in a weak solution of sulfuric acid. Inside the cell some positive hydrogen ions flow toward the cop- per, where they combine with free electrons to form neutral atoms of hydrogen. These neutral hydrogen atoms cling to the copper as a gas and coat it entirely, thus causing the copper electrode to act like an electrode of hydrogen. However, the potential differ- ence between zinc and hydrogen is less than it is between zinc and copper and the emf of the cell is reduced. Due to the decreased emf the cell cannot supply as much cur- rent to an external circuit as before, hence, it is polarized.

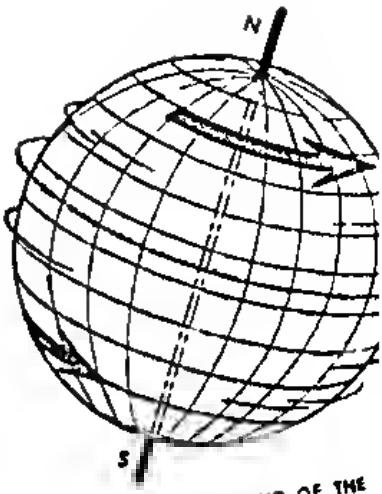
A. E. L

Polaroid see Land, Edwin

Pole (general) A pole is either end of an *axis*. For instance, in physics either end of a MAGNET is its pole. In elec- tricity the pole is one of the two *terminals* of the current source. In biology, the pole is one of the opposite ends of the organism or cell which are pbysiologically different.

Pole, magnetic see Magnet, Elec- tricity

Poles, North and South The earth turns, or rotates, on an axis which is pictured as an imaginary slanted line running through its ceoter. The end point of the imaginary line in the Northern Hemisphere, or northern



A POLE IS THE END OF THE AXIS AROUND WHICH THE EA APPEARS TO ROTATE

The end point of the line ern Hemisphere is the Many times when peopl North Pole or the So mean the general regic end points of the earth

For years these two the goal of many explo century, did men actuall of the earth On April 6 can explorer ROBERT E Matthew Henson, and f the North Pole. These see the sun and stars horizontal circles. Pear to substantiate his cla

On December 16, ROALD AMUNDSEN crossed the South P RICHARD BYRD (U.S which successfully Especially since th PHYSICAL YEAR (1 peditions have pen by land and unde exploration was ered submarine N

Polecat see W

Poliomyelitis (pole-ih-oh-MI-eh-LIE-tis) Poliomyelitis is an infectious disease of the *central nervous system*. People all over the world get the disease. Scientists do not know exactly how the disease-producing *virus* gets into the body to make a person sick.

The VIRUS probably enters the body through the mucous membranes of the mouth. It travels in the blood stream and lodges in the intestinal tract and brain and spinal cord. It is excreted from the intestinal tract during the illness and for weeks after recovery, and may be spread by flies to food. In underdeveloped areas of the world where sanitation is poor, mild cases of poliomyelitis are common, and most children over four have acquired immunity to it.

The virus causes inflammation and partial or complete destruction of the *motor neurons* of the spinal cord. In 99 per cent of the cases, the illness is mild and flu-like; the symptoms last three to four days, and there is no PARALYSIS. Symptoms of more severe but nonparalytic poliomyelitis include pain and stiffness in the back and neck due to muscular spasm. In the severe paralytic type, there is pain and weakness in the muscles and sometimes complete paralysis of arms, legs, respiratory, and other muscles, depending on the area of the central nervous system attacked by the virus. Massage and exercise help restore paralyzed limbs if the spinal cord cells are not completely destroyed. If respiratory muscles are affected, a *respirator* or IRON LUNG is used to help the patient breathe.

The *Salk vaccine* for poliomyelitis was introduced in 1954. It is prepared from three strains of *formalin-killed* viruses. It is not yet known how many shots are needed to provide lasting immunity. The Sabine vaccine, an oral vaccine containing live but weakened viruses, is being widely tested.

E. R. B.

SEE ALSO: MEDULLA OBLONGATA; NERVOUS SYSTEM; SALK, JONAS

(PAHL-enn) If a lily or a dan-
flower is dusted across one's
yellow powder can be seen.
powder is made of tiny grains of

✳ THINGS TO

DO ALL POLLE
ALIKE?

1 Collect flowers from as
as you can find.

2 Spread a thin film of g
center of several glass
slides. Shake a differeot fl
each slide. The pollen will
the glue. Carefully place a co
over each.

3 Observe them under a micr
How many shapes and sizes d
find?

Pollen forms in the *anthers* at the en
the male part of the flower called
stamen. If the flower develops prop
some of the pollen grains are dusted
the head of the female part of the flo
called the PISTIL. From each pollen grain
slender hair-like tube grows down throu
the pistil. A pollen nucleus travels throug
the tube and unites with the little seed-to-be
the *ovule*, in the ovary (the seed case).

V. V. N.

SEE ALSO: ALLERGY; PLANT; REPRODUCTION, SEXUAL

Pollination (PAHL-ih-nay-shun) Seeds develop after flowering only if pollen is transferred from the male part of the flower (*stamen*) to the female part of the flower (*pistil*) of the same kind of plant. This transfer of pollen to the ovule (*future seed*) in gymnosperms, or to the

Pollen forms in sacs in the anther. A—pollen tetrad; B—pollen mother cells; C and D outer layers of cells which dry and crack open to release pollen

Photomicrographs by National Teaching Aids, Inc.

plants, is called *pollination*. Without pollination, there would be no new seed for a new plant.

There are two basic types of pollination. They are called *self-pollination* and *cross-pollination*. Self-pollination is the transfer of pollen from the STAMEN to the PISTIL in the same flower or to the pistil of another flower on the same plant. If pollen from the stamen of one plant is transferred to the pistil of another plant, it is cross-pollination.

When pollen is transferred from one plant to another in cross-pollination, an outside agent or help is needed. The chief agents of pollination are insects, other animals, wind, and water.

BEES are the chief insect pollinators. Moths, butterflies, and certain kinds of flies also visit flowers regularly and in so doing bring about cross-pollination.

Insects visit the flowers to obtain sweet *nectar*, which is secreted deep in the flower from special glands at the base of the petals. The plump, hairy body of the bee is ideal for this process. When the bee tries to reach the nectar glands, located at the base of the flower, it must rub its hairy body against the male anthers of the stamen. These are in most cases located near the entrance of the flower. Then as the insect visits the next flower, some of the pollen is rubbed against the sticky stigma of the female pistil. At the same time a new supply of pollen is brushed off from the stamen onto the bee.

Flowers have brightly-colored petals and sweet odors which attract insects. Nectar guides in some flowers may be brightly colored strips located on the petals. Also flowers arranged in showy clusters make them more noticeable to traveling insects passing by.

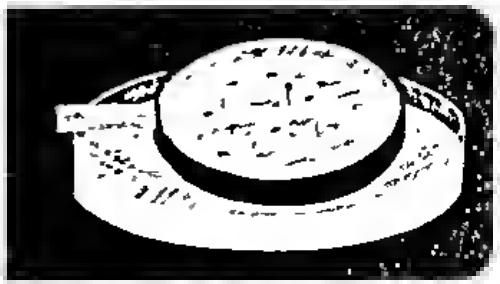
There is one type of bird that assists in pollination. The little HUMMINGBIRD feeds on the nectar of certain types of flowers. It has a long bill and a long tongue to reach down into the nectar glands while it hovers with its delicate wings overhead.

Flowers of wind-pollinated plants are much less striking in beauty than those pollinated by insects. They are usually in dense clusters at the ends of branches. Petals are lacking, and the flowers seldom have any nectar. The stamens are long and produce a large amount of pollen light in weight. The pistils are also long and the stigma large and often sticky, so that they are able to catch wind-blown pollen grains. Pines, cottonwoods, willows, walnuts, corn, oats, and other wind-pollinated plants fill the air with pollen when their stamens are ripe. Some people are allergic to the pollen. V. V. N.

SEE ALSO: FLOWERS

Pollution see Purification

HOW DOES THE POLLEN GET TO THE EGG TO FERTILIZE IT?



1. Make a thin sugar solution. This will serve as a medium in which the pollen grains can grow.
2. Locate a freshly-opened flower. Place the solution in a shallow dish and shake the stamens (the stalk usually with yellow knobs) over the solution. Cover the dish and permit it to stand for an hour.
3. Using a hand lens observe the long extension which has sprouted from each grain. This is the pollen tube which grows down the pistil until its nucleus joins the nucleus of the egg.

The colorful flowers attract bees, (below) who spread pollen by carrying it between stiff hairs on their legs (right)

Photomicrographs by National Teaching Aids, Inc.

Courtesy San city Zoo Visual Education, Inc.

Polonium (puh-LOH-nee-um) Polonium is a chemical element. It is radioactive, like uranium and radium. The symbol for polonium is Po. Its atomic number is 84. Its atomic weight is 210.

Polonium was discovered by Madame Curie in 1898. She named it after her native land, Poland. Madame Curie discovered polonium in some samples of uranium she had obtained from pitchblende.

Polonium is mainly used to produce neutron sources. It is also used in spark plugs and in devices to eliminate static.

Polonium is not found in a natural, simple state. It is found in all uranium minerals, and can be obtained by separating it from uranium residues. It can be produced by bombarding bismuth with neutrons. C. L. K.

SEE ALSO: ELEMENTS

Polycotyledon (pohl-ih-cot-uh-LEE-dun) *Cotyledons* are seed leaves. The food supply of the seed is usually in the form of one, two, or many cotyledons. The term polycotyledons refers to seeds that have more than two seed leaves. Pines, spruces, hemlocks, and other cone-bearing trees are polycotyledons. V. V. N.

SEE ALSO: COTYLEDON, GYMNOSPERMS

Polygon see Geometry

Polymer Molecules of the same kind can be chemically joined together to form a single larger molecule. The new, heavier molecule is made up of the same elements in the same proportions. Its molecular weight is a multiple of the original molecule. This new molecule is called a "polymer."

SEE: CHEMISTRY, PLASTICS

Polymorphism Polymorphism is the occurrence of a plant or animal in different forms or colors. A chemical substance like sulfur is polymorphous when it exists in several crystalline forms.

Polyps Polyps are *coelenterates* of the class *Anthozoa*. They are also the attached forms of some coelenterates which have two forms. They are cylindrical, attached at one end, and have a mouth at the other end.

SEE: COELENTERATA

Pomegranate

Pomegranate The pomegranate tree has been known to man for thousands of years. It is a tree or tall shrub that grows only in tropical or semitropical lands. In the United States it grows best in southern areas.

Small clusters of reddish-orange flowers bloom in the spring and are followed by a reddish or deep yellow fruit called pomegranate. This fruit is the size of a large orange. The outside covering, or rind, of the pomegranate is hard, but inside this sectioned fruit are many seeds surrounded by juicy pulp. J. A. D.

Pomes Pomes are a type of fruit. They are often good to eat and provide one with vitamins and minerals needed for good nutrition. The apple, pear, quince and hawthorne are pomes.

The fleshy part which surrounds a core is the part of pomes that is eaten. The core is a compound of several carpels that have grown together. The *carpel* is the place where seeds develop. These FRUITS usually have many seeds. The seeds of pomes are sometimes called *pips*. M. R. L.

Cross section of a typical pome, the apple

Pompano

Pompano Pompano is the name given to a group of fish found mainly along the Atlantic coastline and in the West Indies. They include the common pompano, sometimes called the *butterfish*, the round pompano and a larger variety, the jack pompano. The butterfish is popular as a food fish.

Pond lily see Water lily

Pons see Brain, Nervous system

Pontoon bridge see Bridges

Popcorn Unlike other CORN, popcorn kernels have an almost moisture-tight coating. When the kernel is heated the steam from the germ inside expands and explodes the starch into fluffy white bits. If regular corn is heated, the steam leaks out slowly at the base and along the soft channel of the kernel.

Poplar (PAHP-ler) Poplars are fast growing but short-lived trees. They form great forests in low lands and on the slopes of mountains. They have broad, heart-shaped, leathery leaves that are pale green above and silvery beneath. The leaves are on long stems. Their flowers are long, and a tiny seed is attached to a cotton-like material by which it is carried through the air.

The wood of the poplar tree is light, soft, and brittle. It is used for making packing cases and paper pulp. Poplars love the sun. They are often planted as WINDBREAKS or between farms to mark boundaries.

Lombardy poplars have a tall graceful shape

Courtesy Society For Visual Education, Inc.

The *cottonwood* grows on the western plains where few other trees can grow. The *aspen*, with a smooth, gray bark, and leaves that ripple in the wind, is the prettiest tree of the poplars. The *balm of Gilead* secretes a wax that the Indians used for sealing up the seams of their birch-bark canoes. The *Lombardy* poplar has upward pointing branches and a long, narrow shape. M. R. L.

SEE ALSO: DECIDUOUS

Poppy The poppy family contains about 200 kinds of flowers in shades of red, orange, and white. Poppy seeds are used to flavor rolls and bread, and are sold as bird food.

The white poppy raised in the Orient produces *latex*, a milky juice found in the unripe fruit. OPIUM, a dangerous drug, comes from this juice. *Morphine* and *codeine*, pain-relieving drugs, are also refined from it.

The red poppy grows wild throughout Europe. Oriental poppies, native to Mediterranean regions, grow to four feet in height. The California poppy was found in 1815 growing in masses where the city of San Francisco now stands. It is the state flower of California. P. G. B.

SEE ALSO: PLANTS, MEDICINAL

California poppies

Courtesy Society For Visual Education, Inc.

Poppy seed Poppy seeds are tiny, deep blue or black seeds used in cooking. Hundreds of tiny seeds are found in each seed pod of the poppy.

Although used by the Egyptians before 1500, it was the Dutch people who developed one species of the poppy plant which gives the walnut-flavored seed used today. The seeds do not contain narcotics.

Poppy seeds are used in baking and flavoring vegetable dishes, salads, and sauces. A gray poppy seed called *maw* is found in commercial birdseed mixtures.

J. K. K.

Porcelain (PORS-uh-luhn) Porcelain is the finest and most expensive type of pottery. It is usually white and *translucent*, meaning that light will shine through it.

Porcelain is made of a mixture of *kaolin* and *feldspar*. These materials are finely-ground and washed and then mixed into a clay. The clay is then worked and kneaded. When the clay reaches the proper consistency, it is shaped into the desired piece either on a potter's wheel or in a mold. If the piece is to have a handle and spout, these are separately molded and attached to the piece with the clay. Then it is set aside to dry, after which it is baked in a kiln or oven at a comparatively low temperature. The baked piece is known as a *biscuit*. The biscuit is then dipped in *glaze* and again fired at a very high temperature.

The secret of making porcelain was discovered in China. The earliest pieces date to about 900 A.D. Porcelain was introduced to Europe in the 15th century. Various Europeans tried unsuccessfully to duplicate this highly-prized chinaware. It wasn't until 1709 that Boettger, a chemist to the Elector of Saxony, succeeded in discovering the materials that compose porcelain. W. J. K.

Porcupine (PAWR-kyuh-pyne) The porcupine is a stout, slow-moving forest animal. Its name means "spiny pig." Its back, sides, and tail are covered with long hair mixed with strong barbed *quills*. These quills, or *spines*, are really long thin hairs which have grown together. They usually lie smoothly over the porcupine's body; however, when it becomes excited they stand out straight and stiff.

Courtesy Society For Visual Education, Inc.

North American porcupine (above) and prehensile-tailed South American (below)

The barbed quills, which are controlled by muscles in the skin, are loosely attached to the porcupine and easily catch on anything which touches them. Porcupines cannot throw their quills as is commonly believed. The porcupine often slaps at its enemy with its powerful tail, causing many of the long quills to become imbedded in the enemy's skin. Once imbedded, they are very difficult and painful to remove because of their barbs. Some enemies of the porcupine, such as the fox, lynx, coyote, and mountain lion, attempt to turn the porcupine over on its back; however, this is difficult to do because the porcupine is able to roll itself up into a compact spiny ball.

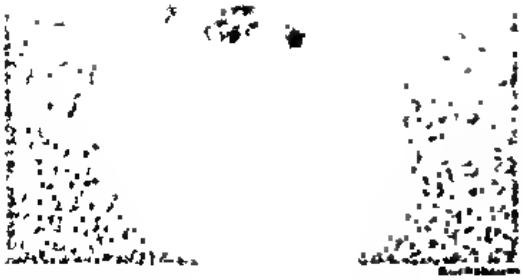
Porcupines are gnawing mammals, feeding mainly on the leaves, buds, and bark of trees and the roots and stems of tender plants. They are especially fond of salt. They are excellent climbers and frequently climb trees in their search for food.

Porcupines have one to three babies each year in early summer. They are usually born under a rock ledge, in a crevice or cave. The babies are large and well-developed at birth, having fur, spines, and teeth. They can live alone in just one week.

There are several species of porcupines. The Canadian porcupine and the yellow-haired or European porcupine are two. The Canadian porcupine, found throughout North America, grows to be about three feet long, weighing up to forty pounds. The European species is smaller. D. J. A.

SEE ALSO: RODENTIA

Pore see Skin, Sweat gland



Tan sponge

Porifera (poh-RIFF-er-uh) Most people use a cloth for scrubbing cars or for washing windows. But some people use an animal, better known as a *sponge*. Although there are many different kinds of sponges, all sponges are covered with thousands of tiny holes or pores. The name *porifera* means "pore-bearer."

People who have used the bath sponge know that it is light in weight. It also remains tough, even when it is wet. The bath sponge has a soft, elastic skeleton of *spongin*. All sponges are held up by stiff, outside skeletons. However, most sponges have a scratchy skeleton of sharp chalk or glass needles.

All sponges live in water. Most of them live in the ocean. Many of those in the warm, shallow oceans have beautiful colors —pinks, scarlets, and greens. Sponges which live either in fresh water or many thousand feet under the ocean are usually colored brown or gray.

The members of this phylum used to be called "plants" or "plant-animals." Adult sponges do not move from place to place. Like plants, they attach themselves to solid surfaces, such as rocks, ground, wharfs, and even the backs of crabs. While many are shaped like branching plants, others look like vases, tubes or cups. Since most sponges live in colonies, they spread out over large areas like thick, flat cushions of moss.

A sponge is like a small, filtering plant. Water enters continually through microscopic pores on the sides of the body. Inside the sponge, it passes into a large, hollow cavity or through an elaborate system of canals. As oxygen and small organisms are removed, wastes and carbon dioxide are passed into the water. From one or more large holes at the top of the body, water leaves in a steady jet stream.

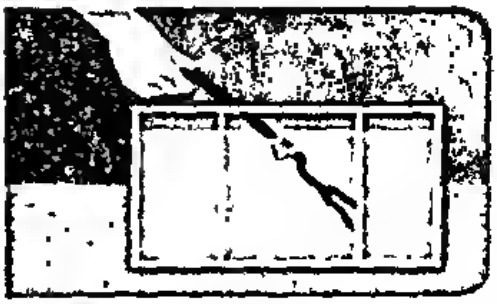
A sponge may also be thought of as a small community of cells, working together in groups. Each group is specialized for carrying out a particular duty. The flat outer cells, which fit closely together like floor tiles, are the protective cells. *Collar* cells line the internal cavity. At the free end, this unusual cell has a long whip-like *flagellum*, protruding from a delicate collar of *protoplasm*. As the flagella beat, they drive water through the inner channels and pull food particles into the collar.

Between the inner and outer cells, there is a jelly-like, non-living substance. Embedded in this are the *mesenchyme* cells, which move like the AMEBA. Some of them receive the partly-digested food from the collar cells, digest it further, and transport it throughout the body. They probably also pass waste materials to the surface. Specialized mesenchyme cells, shaped like hollow rings, are called *pore cells*. These form the openings of pores which lead to the internal cavity.

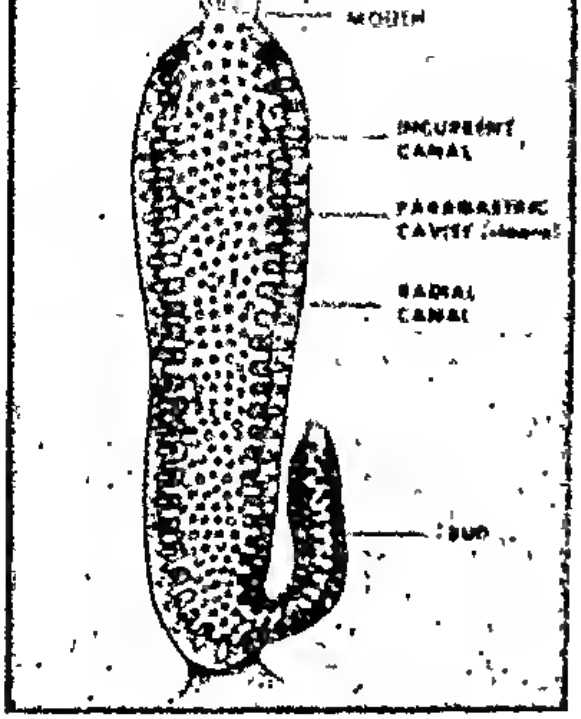
Perhaps the most important duty of the mesenchyme cells is to secrete the skeleton which supports this great mass of cells. Sponges are classified according to the shape and composition of the needles and fibers of the skeleton. *Chalk*, or *calcareous*, sponges have needles, or *spicules*, of *calcium carbonate*. Since the needles are com-

✳ THINGS TO DO

OBSERVING LIVE SPONGES



Take a hike to a nearby pond or stream to look for live sponges. It is a little difficult to find the grayish mass, usually no larger than a moth ball clinging to sticks or stones in the water. Pick up the object they are attached to and place it in a jar of the pond water. Transfer them to an aquarium or larger container filled with the water in which they were originally living. Observe for a few days and then return the sponges to their natural habitat. They will not live long in captivity.



Longitudinal section of a sponge

monly shaped like a "T" or a "Y", they interlock and overlap. Most chalk sponges are small marine animals with drab color. Found in the deepest ocean water, the true *glass* sponges have beautiful six-rayed spicules of silica.

Four-fifths of all sponges belong to the class of *horn* sponges. Included are all glass sponges without six-rayed spicules, as well as sponges with horny, elastic skeletons, made of a protein secretion, called *spongin*. A few members have skeletons of both silica and spongin. Apart from the bath sponge, the horny sponges have little commercial value since the skeleton collects foreign matter, such as bits of rock.

Any portion of the sponge is able to produce an entire new animal. Some sponges reproduce asexually by budding and branching. However, all sponges are able to reproduce sexually. Eggs and sperms may be produced within the same individual, or within separate individuals. Since the free-swimming larva moves about before it settles down to become an adult, sponges are distributed over a wide area. E. P. L.

SEE ALSO: AMEBA; ANIMALS, CLASSIFICATION OF; SILICON

Porosity Porosity is the characteristic of being *porous*, or filled with tiny holes through which water, air, or the like pass. Sponges and sandstone are porous. VIRUSES can pass through pores in porcelain filters.


Porpoise

Porpoise (PAWR-puss) Porpoises are small, playful whales, found along the coasts of North and South America, Europe, and Africa. These warm-blooded mammals are closely related to dolphins and are often confused with them. However, porpoises are smaller than DOLPHINS and they do not have beaklike snouts. Porpoises live in the shallow water of ocean bays and the mouths of rivers, while dolphins live out in the deeper waters.

Porpoises swim near the surface of the water, traveling in large schools or herds. Sometimes these schools include several hundred porpoises. They are air-breathing animals. Warm air is exhaled through a single breathing hole (*blow-hole*) on the porpoise's head. This warm air vaporizes into a hissing jet of steam when it is expelled into the colder outside air.

The common porpoise is about six feet long, weighing from 100 to 120 pounds. Its smooth whalelike body is black above and white below. It has a triangular dorsal fin in the middle of its back. This porpoise has twenty-five pairs of short, sharp teeth in each jaw. It eats salmon, mackerel, herring, cuttlefish, and crustaceans. Schools of these porpoises often travel great distances in their search for food. Baby porpoises, about three feet long, are born in the spring. They, like other mammals, are nursed by their mothers. D. J. A.

SEE ALSO: CETACEA, MAMMALIA, WHALE

Portugoese man-of-war see Man-of-War, Portuguese

Portulaca (pohr-tchuh-LACK-uh) Portulaca is a small herb or flower that deserves respect. A native of Brazil, this little flower grows where nothing else will. It thrives in hot, dry, almost impossible places. Portu-

Portulaca thrives in dry soil

laca is also called *moss rose*.

Portulaca grows close to the ground, seldom reaching over one foot in height. It has narrow, fleshy leaves and brilliantly colored flowers. They may be white, red, pink, yellow, or purple. Portulaca is often used as a border flower.

There is a kitchen-garden variety of portulaca that is used as a cooking herb. It grows to one and one-half feet tall, has bright yellow flowers and leaves one-half inch wide.

J K K

Positron (PAHZ-uh-trahn) The positron is a particle smaller than an atom. It is identical to the *electron* in size and weight, but has a positive rather than negative charge. It was discovered by C. D. Anderson at the California Institute of Technology in 1932. He discovered positrons while studying cosmic radiation with a CLOUD CHAMBER. He named the positron for its *positive* charge and its similarity to the *electron*.

Positrons can be formed through the change of a PROTON into a neutron inside the nucleus of an atom. Such a change occurs spontaneously in many radioactive elements. The positron can combine with a free ELECTRON and the two disappear by forming two gamma rays. This is called *annihilation radiation* because the electron and positron disappear. In the absence of electrons (in vacuum) the positron is stable and can live forever. In the presence of matter, such as most solids, the positron lives a very short time (one-billionth of a second).

Positrons were predicated theoretically, before their experimental discovery, by the English physicist P. A. M. Dirac. In Dirac's theory, negative energies f
as well as the ordinary po
positron comes into existen
tron is removed from the
negative energy states. The
the electron is the positron
a hole, energy must be put i
When a PHOTON is absorbed
of a charged particle, one neg
and one positive positron are
process is called *pair production*

Posterior Posterior means
ward, the hind end of an
also means *caudal* on some
SEE ANIMALS CLASSIFICATION O

Posture To have good postur
be one of the most importan
goals. With head held hig
shoulders level, a person will fe
ter. Good posture helps the
move freely to the brain, and
helps a person to think better
organs with which people bre
digest food, and get rid of waste
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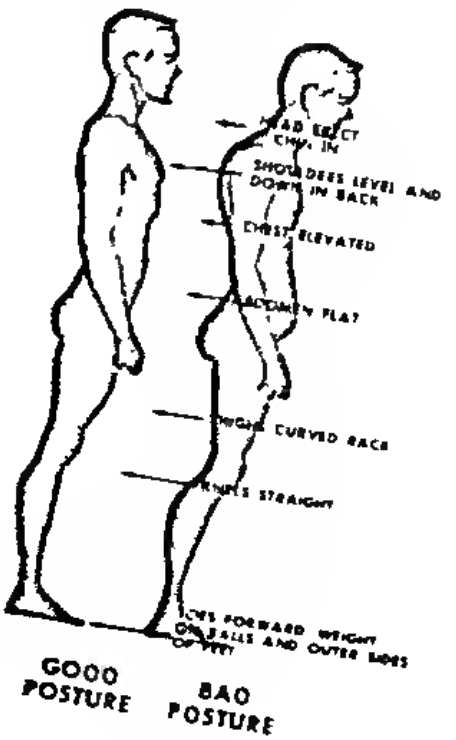


Potash Potash is a name often used for a chemical known as *potassium carbonate*. This chemical was originally obtained from wood ashes and thereby received its name. Potash is used in the manufacture of soaps and glass.

Potassium carbonate is very soluble in water, and the solution that results is alkaline. In its dry or *anhydrous* form, it takes up water very readily even from the air itself. For this reason it is used to remove water from organic liquids when the water is not wanted.

In its pure dry form, potash is a white, odorless, granular powder. Its chemical formula is K_2CO_3. Its molecular weight is 138.2. M. S.

Potassium (puh-TASS-ee-um) Potassium is one of the alkali metals and the 19th element. It was first prepared in the pure form by SIR HUMPHRY DAVY in 1808. It appears as a soft silvery-white metal when pure. In the form of various minerals and salts, it makes up 2.4% of the earth's crust.

Potassium is one of the most active metals known. It reacts with the oxygen in the air and very vigorously with water. In order to keep potassium from reacting in storage, it must be immersed in a liquid that does not contain oxygen, such as petroleum or other liquid hydrocarbons.

Its main uses are in chemical reactions to make other compounds or salts containing potassium. Some of the more familiar compounds and their uses are as follows: potassium *bicarbonate* in baking powders; potassium *bromide* as a sedative; potassium *carbonate* (potash) in soap manufacturing; potassium *chlorate* in fireworks and EXPLOSIVES; potassium *chloride* in medicine; potassium *dichromate* in leather tanning; potassium *ferrocyanide* in dyeing wool and silk; potassium *hydroxide* in soap manufacturing; potassium *iodide* in analytical chemistry; potassium *nitrate* in gunpowder; potassium *oleate*, a soap; potassium *permanganate*, an antiseptic; potassium *persulfate* for bleaching fabrics; potassium *sulfite* in photographic developers.

Potassium has the chemical symbol K and has an atomic weight of 39.1.

Recently, potassium has become important in dating materials that are older than the carbon-14 method can date. A very active ISOTOPE of potassium, K^{40}, slowly but steadily changes into argon-40. For example, it would take 1 3/10 billion years for half of 18 K^{40} atoms to decay to argon-40. The time is long but it can be calculated from the number of K^{40} atoms remaining. The discovery that man may be one million years older than previously thought is the result of such calculation. M. S.

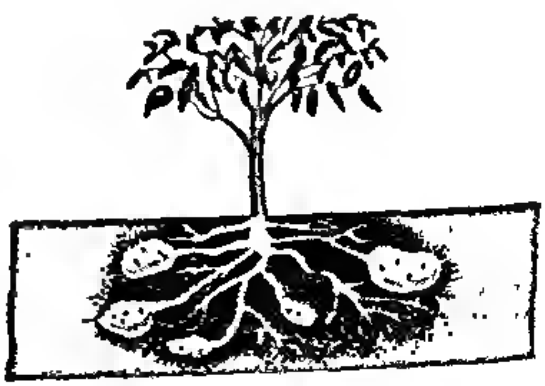
SEE ALSO: ELEMENTS, ELEMENTS IN THE HUMAN BODY, NUCLEAR SCIENCE

Potato In France the potato is called "apple of the earth" for the potato grows under the earth. Just as the apple is the most popular fruit grown, the potato is the most popular vegetable grown.

The potato plant looks like its relative, the TOMATO plant, with spreading stalks and dark green leaves. The flowers are small and white, bluish or yellow. Underground, the plant grows stems called *stolons*. The end of the stems develop into *tubers* which are called potatoes. *Buds*, or *eyes*, grow on the potato. New potato plants can be started by planting a piece of potato that has an eye.

Great Britain, Germany, Maine, Montana and Idaho grow many potatoes. Spanish explorers discovered the potato in South America and brought it to Europe in the sixteenth century. It has become an important food, being easy to digest and nutritious and cheap P. G. B.

Potato plant; underground are stolons and tubers



Potential Potential is a measure of the amount of a stored quantity available for possible use. Potential ENERGY is energy of position. It is the work which has been done to put something in a potential where it is ready to move due to the presence of some force. This force may be gravitational, mechanical, electrical, magnetic, etc.

Potentilla

Potentilla (poh-tuhn-TILL-uh) Potentilla is the name of certain plants that grow wild on lawns and prairies in the eastern part of the United States. They are sometimes called *five-finger* plants because each leaf is divided into five parts. Since some are creeping vines that resemble strawberry plants, they are also called *false strawberry*. The flowers are bright yellow, and grow in small clusters.

Potentilla plants grow in poor soil. If many plants grow in an area, it may be a sign that the soil is acid or sour and trees should not be planted. P. G. B.

Poultry see Chicken, Fowl

Pound see Foot-pound, Measurement

Power Power depends upon how fast work is done. WORK is done whenever a push or pull moves something. The work may be done slowly or quickly. If work is done quickly, greater power is expended than when it is done slowly.

The push or pull needed to move something is called *force* and the work done is the force times the distance the object is moved. Power $= \frac{\text{work}}{\text{time}}$. If a boy weighing 80 pounds climbs 20 feet up a ladder, 1600 ft-lbs. of work is done against gravity. The force the boy needs to climb the ladder equals his own weight. If the boy climbs the ladder in 4 seconds, the power $= \frac{1600 \text{ ft-lbs.}}{4}$ or 400 ft-lbs. per sec. If he takes 8 seconds to climb, the power is less. Power $= \frac{1600}{8}$ or 200 ft-lbs. per sec. Thus power is the time rate of doing work.

Power may be expressed in many different units such as *horsepower* and *watts* (*joules* per second). When the time rate of working is 550 ft-lbs per second (or 33,000 per minute) the power is one horsepower. The watt rating on an electric light bulb gives the rate at which electrical energy (work) will be consumed when the bulb is used. The 100 watts means 100 joules per second. This is a unit of power MEASUREMENT in the metric system. J. H. D.

SEE ALSO. ENERGY; MACHINES, SIMPLE

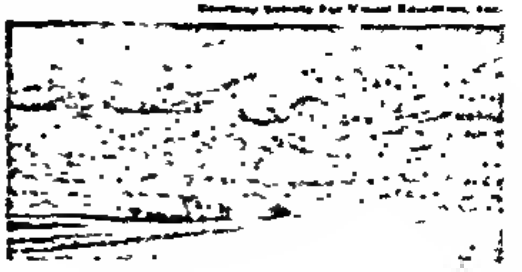
Prairie A prairie is a broad stretch of grassland. The name was given to the large area of the Mississippi Valley by early French explorers. The prairie is the region located in the central part of the United States. It is bordered by heavy forests on the east and the mountains on the west. It is from 300 to 1400 feet above sea level.

The prairies are considered treeless, but the streams running through them are lined with many varieties of trees. The open country is covered with coarse grasses and other kinds of vegetation. The soil is dark and fertile, and covered with a layer of fine dust. The climate of the prairies is severe since it is unprotected from the winds in winter and the intense heat in the summer. It has an annual rainfall of about 30 inches, occurring mostly in the spring and summer. W. J. K.

SEE ALSO: GEOGRAPHY, NORTH AMERICA

Prairie chicken see Grouse

Prairies are vast open areas with few trees



Prairie dog colony

Prairie dog The prairie dog is a small, wild rodent with very short ears and a short, flat tail with a black tip. This stout, sturdy little animal is about fifteen inches long, and has coarse brownish fur with some gray and black hairs. Prairie dogs like the high dry prairies of the west. They are found from Texas and Kansas to the Rocky mountains, and north to Montana.

Prairie dogs live in large colonies. Their underground burrows are very cleverly constructed and may cover many miles. Each opening into the burrows has a mound of earth around it to prevent rain water from running in. The prairie dog will sit in the opening like a guard and watch for danger. In case of danger, it sounds a shrill alarm and quickly ducks into the burrow. Just inside the burrow entrance are rooms where it goes to listen for the danger to pass. Farther down in the burrow are many passages and rooms. Some are lined with grass for care of the young. Prairie dogs live on grasses, weeds, and some insects. M. R. L.

SEE ALSO: RODENTIA

Prairie wolf see Coyote

Praseodymium (pray-see-oh-DIMM-ee-uhm) Praseodymium is a scarce metallic element of the *rare-earth* group. It occurs in *cerite* and other rare minerals. The symbol for praseodymium is Pr. Its atomic number is 59 and its atomic weight is 140.92. In its free state it is silvery-white but its salts are green.

Its common oxide (Pr_6O_{11}) is a black powder. The salts of praseodymium are produced by dissolving the black oxide in an acid. These salts are used in the ceramic industry for glazes and coloring glass.

Von Welsbach discovered the element in 1885 when he separated the salts of *didymium* into praseodymium and NEODYMIUM. E. R. B.

SEE ALSO: ELEMENTS, OXIDATION

A mantis searching for prey

Praying mantis The mantis or *mantid* is often called the praying mantis because it holds its forelegs as though it were praying. Although primitive tribes thought these insects had supernatural power and could even answer questions, the praying mantis is only a greedy, harmless, and amusing insect. Actually, when the mantis sits with "folded hands," it is not praying but waiting for its prey. Mantises are found in warm countries. However, the common European mantis can survive in the northern United States, where it is more than welcome because it eats harmful insects.

The mantis is a cannibal, for it eats other mantises as well as other insects. The female often eats its own mate.

Related to the grasshoppers, crickets, and cockroaches, the mantis is slender with long, locust-like legs, oval wings, a long neck or *prothora*, and an angular movable head with large, protruding eyes. The front legs are stout, spiny, and fitted for seizing their prey like a spring trap. Mantises measure two to five inches long. They resemble the leaves of plants. J. K. L.

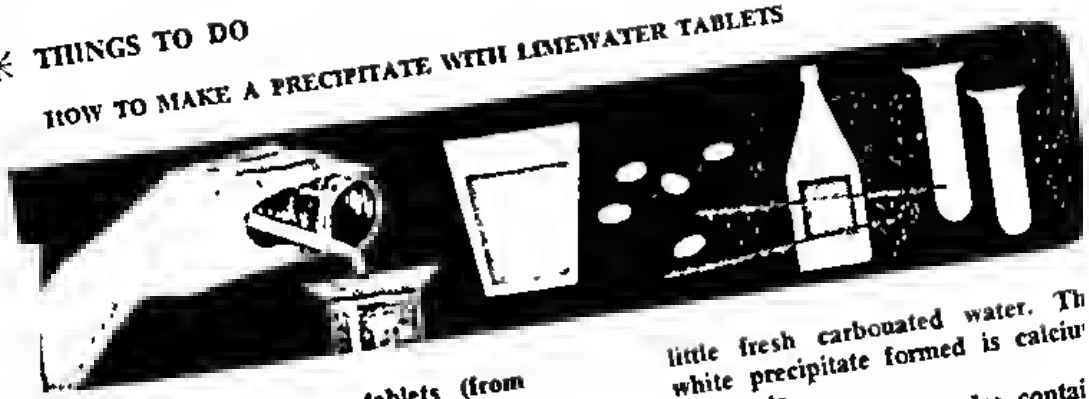
SEE ALSO: INSECTA

Pre-cambrian see Geologic time table

Precious stones see Gem

✳ THINGS TO DO

HOW TO MAKE A PRECIPITATE WITH LIMEWATER TABLETS



Materials: Limewater tablets (from drugstore), 2 tumblers or test tubes, funnel, filter paper, soda water, straw

1 Dissolve 1 or 2 small limewater tablets in a tumbler of cold water. Keep weak lime solution off of skin.

2 Filter the milky solution with a funnel lined with filter paper. Do this within ½ hour, since carbon dioxide of the air will recloud the clear liquid coming through filter.

3 Divide the resulting clear limewater into two portions. To one, add a little fresh carbonated water. Th white precipitate formed is calciu carbonate.

4 Show that your breath also contai carbon dioxide that will make li carbonate precipitate. Simply bl with a soda straw into the weak, cl limewater.

Note: If you breathe too long, white carbonate will redissolve. is because it forms soluble, precipitated calcium hydrogen carbonate.

D.

Precipitation (chemical) (pruh-SIPP-ih-tay-shunn) When some specific chemical is added to a solution, a solid mass of new chemical is often formed. This solid material is the result of a reaction between the solution and the chemical which has been added to it. The new, insoluble substance is a *precipitate;* and the process by which it forms is called *precipitation.*

Two common examples of precipitatiou ...: (1) the formation of a white, finely-ided cloudy mass (*calcium carbonate*) ıen a person blows his breath (with *car-on dioxide* in it) into clear *limewater;* (2) ıe formation of a white scum (which in ıost hard waters is *lime-* and *magnesium-oap salts*) when soap is mixed with hard water.

Four conditions or factors affect precipitation: (1) the solubility of both original and newly formed chemicals in a given reaction; (2) the particular concentration of chemicals—including *ions,* if any—in the mixture being studied, (3) the temp of the mixture; (4) the chemical (*chemical equation*) of the mixtur studied. Other factors important complex precipitations include (a) t of *super-saturation,* and (b) the law *action,* which is a mathematical r cerning the strength of each type *cule,* or ion, in the reacting solut

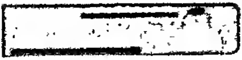
Certain changes in complex *colle* tions seem to be precipitations bı are not. For example, when clear is cooked to a white solid or curdles, the change is a molecul one, called *coagulation*—not tru tion. Again, when a solution heated to remove water and ot residue, that process is *separa poration.*

Precipitation is widely used It finds its two most important the identification of chemicals unknown composition, and, separation of certain chemica solidified form from their r cessed mixtures.

SEE ALSO: CHEMISTRY

* THINGS TO DO

WHERE DOES RAIN COME FROM?



1. Place a wooden flat of grass on a table near a kettle of boiling water. Hold a pan of ice cubes or crushed ice over the spout. As the steam hits the cold bottom of the pan droplets of water will form. As the drops increase in size they will fall on the grass as rain.
2. The warm air coming from the tea kettle is laden with water vapor. As it hits the cold surface it must condense some to liquid water. Cool air cannot hold as much moisture as warm air.

Precipitation (weather) (preh-SIPP-ih-tay-shunn) To the weather student, the word "precipitation" means "rain," "snow," "hail," "dew," or "frost." Except for dew and frost, all these forms of precipitation fall from the sky onto the earth's surface.

Weather scientists (*meteorologists*) constantly try to increase the knowledge about how precipitation occurs. Weather experts, besides observing and predicting daily movements and changes of winds and temperature, must understand the basic physics of precipitation.

Four factors determine whether or not "tomorrow it will rain"—first, the humidity of an approaching low-pressure air mass, next, the air-mass temperature; then the nearness of another approaching, cold-air mass; finally, the kind of dust particles (called *nuclei*) in the air masses. Recent research has revealed still another factor—the position and motion of high-altitude jet streams of air.

Under ideal conditions, some form of precipitation will occur when a warm, moist (*humid*) air mass meets a cold, dry and dense mass. The meeting boundary of these two masses is a *front*. The cold air will usually push along the earth's surface underneath the warm mass. Thus the humid, warm moist air is forced to rise. In so doing it expands and starts to cool. This rising and cooling (*adiabatic*) process makes the warm, humid mass unstable. It can no longer hold its mixed water vapor as a gas. Instead, this vapor must condense either into *rain drops* or into *ice crystals*. This condensation appears as precipitation (nimbus or cumulonimbus) clouds. Still rain has not fallen.

The resulting rain droplets (or ice crystals) are so dense that they at once begin to fall downward through the updrafting currents of the cloud. If in their downward course they meet air at or below freezing, the condensed particles finally fall to earth as *snow flakes*. If, however, the lower air is above freezing, then the falling particles reach the earth as rain drops.

Sometimes, right after the first droplets are condensed in a rain cloud, a stronger updraft sweeps them upward several thousand feet and into the cold anvil head of the nimbus. There they freeze quickly, not into crystals, but into *hailstones*. Their gravitational force finally gains over the updraft, and these small hailstones start downward, often meeting other freezing droplets that add more layers to their icy globes and finally reach the earth.

Dust particles of certain types (sea salt and clay dust) are important in starting precipitation, for a rising, warm-humid cloud often will not start condensing into drops or snowflakes when in pure, dust-free air. Scientists say that the cloud's vapor is super-cooled. The nimbus cloud may move away without rain or snow ever forming and falling from it in that region. If dust particles are present, however, they form precipitation nuclei that enable the cloud's vapor to condense upon them, acting as "starters" for droplets.

In 1946, scientists first used the idea of providing artificial precipitation nuclei to cause rainfall. Powdered *silver iodide* and *dry ice* were used for the nuclei, or *cloud-seeding*, chemicals. To distribute the chemicals, they flew airplanes which carried the powder in spraying machines. The planes flew over nimbus clouds, and also above warm-air masses, and thus "seeded" them. Results of these and later rain-making experiments have been considered promising, but not always clearly successful. J. R. S.

SEE ALSO: CLOUDS, RAIN-MAKING, WEATHER

Predator see Balance of nature

Moropus, a prehistoric relative of the horse

tiles). During the middle of the Cenozoic Era, there appeared dog- and cat-like animals. The *Hyaenodon*, a hyena-like animal, lived during this time. Later in the era the ancestors of the ELEPHANT developed. During the Ice Age, less than one million years ago, *wooly* MAMMOTHS and MASTODONS roamed the ice-covered lands. Early camels, *llamas*, one-toed horses, and *giant ground sloths* wandered over the plains.

Some present-day mammals, such as the *opossum* and *rhinoceros*, look very much like their prehistoric ancestors. Others, such as the horse and elephant, look very different.

Early plant-eating ancestors of the rhinoceros lived during the Mesozoic Era. *Uintatheres* were about the size of elephants. They had heavy legs, small brains, clumsy bodies, and three pairs of bony horns on top of their heads. *Titanotheres* were giant beasts fifteen feet tall. They had two big horns on the ends of their noses and saddle-shaped skulls which had little room for brains. The *Baluchithere*, a rhinoceros-like animal eighteen feet tall at the shoulder, lived in Asia.

The horse family began with a small horse the size of a fox. It was called the *dawn horse* (*Eohippus* or *Hyracotherium*). It had a few stiff hairs (instead of a mane), a small tail, and short neck. It had four toes on its front feet and three on its hind feet. After thousands of years the dawn horse developed into a three-toed horse known as the *middle horse* (*Mesohippus.*) About the same time, there lived a similar animal called a *Moropus* that developed claws instead of hoofs. Over the years, horses grew larger and larger. Their three toes gradually evolved into one toe which became a hoof.

The elephant family began with a small piglike animal with two large front teeth. It was called a *Moeritherium*. As its descendants grew bigger, they developed longer legs, and necks, tusks, and a trunk. The *Palaeomastodon* stood three feet tall and had a short trunk and short tusks. The elephant family continued to change for millions of years.

Other Ice Age mammals included the *giant ground sloth* (*Megatherium*), a plant-eating beast with a heavy body, a large thick tail, strong legs and huge curved claws; the *Glyptodon*, a huge armadillo-like animal with a spiked tail and a suit of armor; the *Irish elk*, which had antlers seven to eight feet wide; and shaggy-coated *ancient bison*. Many of these large mammals died out as the earth changed. Others developed into the mammals known today. O. J. A.

SEE ALSO: EVOLUTION, PALEONTOLOGY

Prehistoric man see Evolution of man, Stone Age

Presbyopia see Optometry

Prescription see Drugs

Preserves In an effort to preserve some of man's NATURAL RESOURCES (which include plant and animal life) from public and private misuse, preserves or reserves have been established by Federal, state and local governments and by individuals.

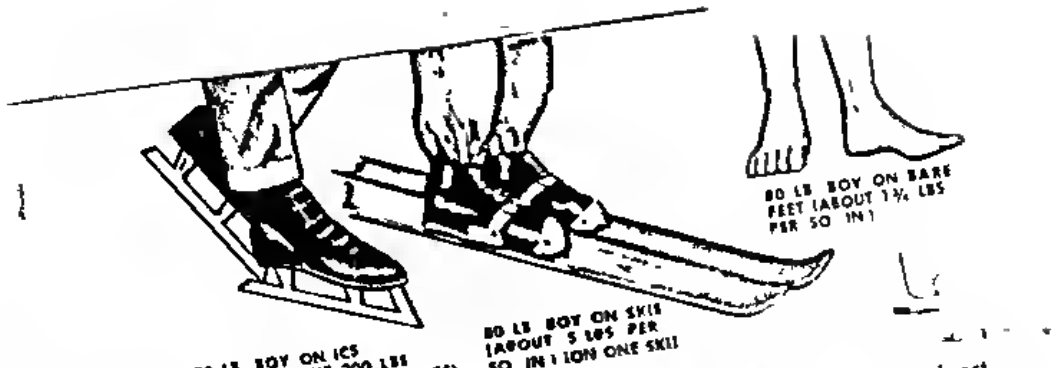
Large tracts of land have been set aside by agencies for the protection of those species of wild animals and birds commonly hunted as game. The killing and disturbing of wild life on these reservations usually is prohibited at all times.

The game preserve of today usually is established for the sake of the game and is, in essence, a wildlife sanctuary.

In this nation's early days, the timber supply was considered inexhaustible and no measures were taken to perpetuate the forest areas. With the rapid development of the lumber industry, timber depletion became so acute that steps were taken to protect and reestablish the forests.

A project which teaches conservations and the importance of guarding wildlife and wild flowers is the Bowman Hill State Wild Flower Preserve in Pennsylvania. Here is a collection of wild flowers and shrubs established for their certain preservation.

Mountain Lake Sanctuary in Florida is a "miscellaneous" nature preserve. It was given to the American people by Edward Bok in 1929 to provide a retreat for man and refuge for Florida's birds. D. L. D.



The pressure exerted by an object on a surface depends in part on the size of the object

Pressure Pressure is the force (or push) on some area of an object. Pressure is often measured in pounds per square inch. For example, pressure of the air at SEA LEVEL is about 15 pounds per square inch. Pressure may be produced by solids, liquids, and gases. When a person dives under water, the pressure on the body is greater than AIR PRESSURE because the weight of the water above exerts pressure too. When a boy or girl skates on ice, the pressure under the runner of the skates is very great because of the weight of the body on the small area of the runner.

Pressure in a LIQUID depends upon the height (depth) and the density of the liquid. The pressure at any depth = h × d When a submarine dives to a depth of 400 feet, the pressure due to the weight of the sea water is about 26,000 pounds per square foot Sea water has a density of about 65 pounds per cubic foot, and the pressure = 400 ft × 65 lbs. per cubic foot or 26,000 lbs per square foot. The total force on the hull of the submarine is much greater than this because of the large number of square feet of surface exposed to the water. A submarine is limited in how far it may descend because the pressure increases with an increase in depth.

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SEE ALSO: BAROMETER, GAS, HYDRAULICS, MEASUREMENT, WEATHER

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SEE BAROMETER

Prickly heat Prickly heat, or *miliaria*, is a rash which is usually located in, or near, the sweat glands. The rash itches and burns. It is caused by extreme heat. It may provide an opening for a skin infection.

Prickly pear see Cactus

Priestley, Joseph (1733-1804) Though Joseph Priestley is primarily known as the English clergyman who discovered oxygen, he was a man with many talents. Priestley was awarded a doctor of law degree from the University of Edinburgh for an essay on education and for writing biographies of important men through the ages. While collecting materials for his biographies Priestley traveled to London where he met Benjamin Franklin At Franklin request, Priestley wrote a *History* *Electricity* which was so successful that Priestley was invited to become member of the Royal Society. He thirty-three years of age at the t

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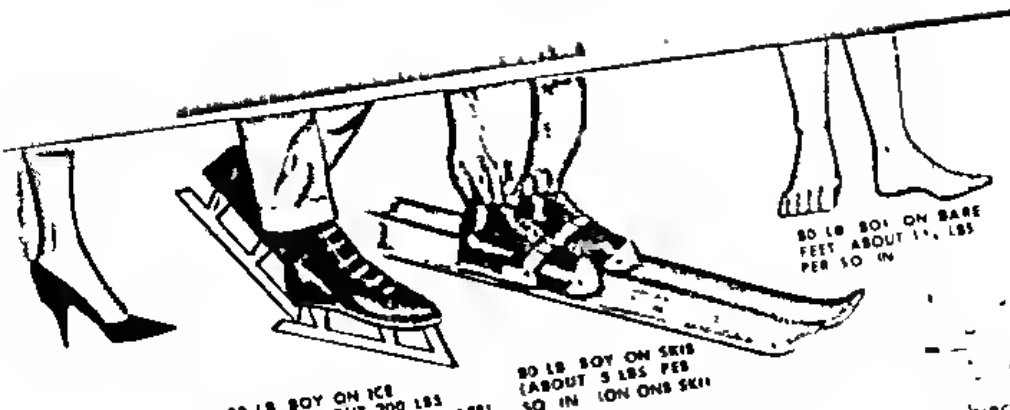

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Joseph Priestley

hung above the liquid in the large fermentation vats. Soon he moved to another location, and there he was successful in making carbon dioxide by pouring acid on chalk. Then he dissolved the gas in water and obtained carbonated water.

In 1774, Priestley obtained a new gas from mercurie oxide that he called a new kind of air. He suggested that it might be used to aid breathing in certain instances, and this suggestion proved to be the forerunner of oxygen tents.

This diseovery of a new gas brought Priestley even more fame and led to a meeting with ANTOINE LAVOISIER and other important scientists in Paris. Lavoisier immediately repeated Priestley's experiments with the new gas, and then named the gas *oxygen* because of its acid-forming properties.

By 1780 Joseph Priestley had alienated his patron Lord Shelburne, whom he had been serving as librarian and literary companion since the time he had received the Copley Medal In searching for a place to go, he found a small, liberal, outcast group in Birmingham that wanted a minister. For ten years he lived happily in Birmingham. There he wrote the last two volumes of the six-volume treatise *On Different Kinds of Air* However, he made many enemies by writing sympathetically about the cause of the American Revolution, and later about the French Revolution. His *History of the Corruptions of Christianity* also aroused many people. On the second anniversary of the French Revolution (July 14, 1791), a mob descended on Birmingham and destroyed Priestley's home, his church, and his laboratory. The siege lasted three days Fortunately Joseph Priestley escaped to London in disguise, where he lived for three years. He was so unhappy there that he decided to go to America. Upon arrival, he was offered a post as a pastor and another as teacher, but he declined both. Instead, he settled in [illegible], Pennsylvania, where he [illegible] and laboratory. There he [illegible] the last ten years of his life [illegible]

[illegible] color, see Color

Primates (PRY-mahts) Primates are the group of *mammals of which man* is a member. Many primates walk uprightly or semi-uprightly. They live in warm regions. The primates include the monkey and similar animals. They often live as *families* within groups.

Primates are generally distinguished from *other mammals in several respects.* The nervous systems tend to be more highly developed. The brain ease is larger. Primates have "hand-like" parts and flat walking feet. Nails, at least on some digits, instead of claws are typical. The two eyes surrounded by a bony ring, are aimed frontward, and focus on the same object. This ability promotes distance perception, a valuable adaptation to tree-swinging animals.

There are eight families among the primates. Animals representative of each are as follows, with the scientific family name in parentheses:

Aye-Aye (*Chiromyidae*): This cat-sized animal has a long bushy tail and claws on its back feet except the flat-nailed big toe. Aye-Ayes live in Madagascar.

Lemur (*Lemuridae*): This squirrel-sized animal is quite unlike other primates except for the feet. There are many kinds of lemurs, some very peculiar looking, especially the loris *Lemur* means "ghost." They are found principally in Madagascar

Tarsier (*Tarsiidae*). These are among the most primitive primates. They have big staring eyes, long ankles, and jump like frogs They are rat-sized, living in the East Indies.

Marmoset (*Hapalidae*) These small primates have prehensile tails and resemble monkeys. They are natives of Central and South America.

Baboon (*Cercopithecidae*) This is one of the Old World monkeys They typically have nostrils close together, directed downwards They have heavy-skinned naked areas The face is dog like

Capuchin monkey (*Cebidae*): Of many New World monkeys, the Capuchin is particularized as the organ grinder's monkey. Animals of this group are small to medium sized. They have long tails and great toes. They have long prehensile tails and widely separated nostrils

The primate family ranges from the primitive lemurs and tarsiers to man.

Courtesy Society for Visual Education, Inc.

ler monkey (above), Baboons (below)

HAND OF OLD WORLD MONKEY

HAND OF MAN

fanlike apes (*Simiidae*): These are the ıropoid apes, or manlike apes, man's ıest animal kin. All probably had a com· ı ancestor as, similarly, would dogs, cats, s, and wolves. The *anthropoids* (man-) are larger than monkeys, possessing ıer brains.

'our main anthropoid types are the long- ıed *gibbon;* the reddish-haired *orang-* ı; appealing *chimpanzee* (easiest to n to amusing human ways); and the ıerful *gorilla*, mentally less acute than chimpanzees, and most ferocious. rillas are short-lived in captivity.

Anthropoids are skeletally like man. Ears round and flat; unlike man's they are lobed. They aren't completely upright atures and cannot talk or use fire. They more manlike than the monkeys.

Man (*Hominidae*): Man, *Homo sapiens*, a brain twice that of the highest ape. He completely upright, two-footed walker. is less hairy than other primates. His ntal development has become his chief ıptation to living anywhere he desires; he indeed "king of beasts." This advanced mentality has replaced physical adaptations and developments by which lower animals live successfully. O. J. I.

SEE ALSO: APE, CHIMPANZEE, EVOLUTION, EVOLUTION OF MAN, GIBBON, GORILLA, LEMUR, MAMMALIA, MONKEY, ORANGUTAN

Prime meridian see Time zones

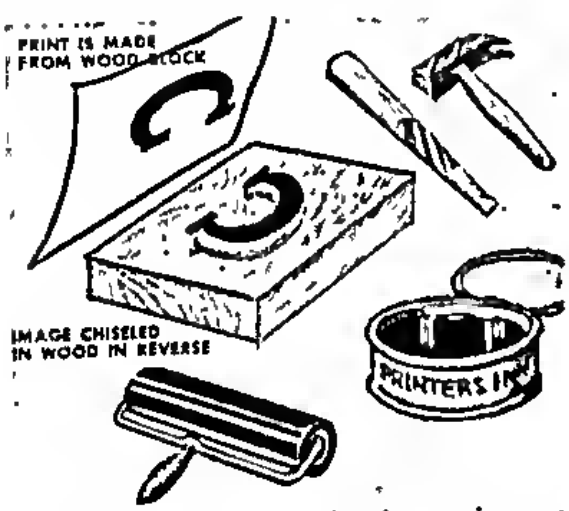
Primrose The primrose is a beautiful garden flower of many shades. The center is usually a different color than the blossom around it. Its name comes from the Latin *primus* meaning "first."

Primroses need shade and good soil. The common white primrose grows wild in woods and meadows of Europe. Primroses can be grown in flower pots for an attractive window garden. P. G. B.

Printed circuit A printed circuit is an electrical circuit which is made without the use of wires. It is usually made by imprinting a thin sheet of a non-conductor (such as plastic) with the circuit in a conducting material (such as silver).

Since printed circuits have no joints or other parts which can become loosened, they are very reliable; since they can be printed on flat sheets, they can be made very small. For these reasons they are used both commercially (as in TV sets) and in scientific instruments, as in space vehicles. D. A. B.

SEE ALSO: ELECTRONICS, TELEVISION



The basic process in printing is pressing one object against another

Printing Most people have watched a grocer stamp prices on cans of food. He first presses a small rubber stamp against a pad of wet ink. Then he presses the stamp against the can and it leaves an ink mark. The stamp is a special tool for making a print. It may be used for making thousands of identical marks. Printing is done by pressing one object against another so that leaves a mark.

Almost any object will make a ark on another object. Some objects deep prints in soft materials. ingers leave prints in cookie dough. But a hand pressed against the hard surface of a table will not leave a mark. The hand, like the grocer's stamp, must be dampened with ink.

People have learned how to make tools and machines which print. The typewriter is a machine for printing words. The letters are raised on metal blocks. As they strike hard against the inked ribbon, they press a mark into the paper. But small typewriters could not print the millions of books needed. Newspapers and books are printed on *presses* (large machines run by electricity). These presses are able to print thousands of pages an hour.

There are so many newspapers and magazines printed today that millions of pounds of used paper are turned over to scrap collectors each week.

Used paperback books lie dusty on shelves. And yet, the earliest printed books and pamphlets are preserved in museums. People are so accustomed to reading printed matter that it is hard to realize a method for printing was developed only about fifty years before Columbus discovered America.

HOW PRINTING BEGAN

In all civilizations, people have wanted to record their ideas. Early man scratched and painted on rock pictures of men or of animals he hunted. Like stories in a printed book, these rough sketches are records which tell of the events of man 200,000 years ago. In later civilizations, man learned to make symbols which represented particular words. It was not until 25,000 years ago, however, that the Phoenicians finally worked out a system for writing individual sounds. From this discovery, they were able to produce the first alphabet. Later other alphabets came into existence. With an alphabet, spoken words could be accurately recorded.

The next problem was that of reproducing identical copies of words and pictures. The ancient Egyptians and Babylonians were the first to develop tools for printing. By carving symbols into wood or stone, they made small band stamps. These were used for making prints in soft metal coins or clay pots. In fact, the Babylonians invented a tool for printing a complete paragraph. Letters were scratched around the surface of a wooden cylinder. An entire paragraph could

Pages and sample letters from the Gutenberg press with movable type

olled onto a soft clay tablet with one of the cylinder.

eople had not as yet learned how to e ink marks on paper. It was not until 5th century A.D. that the Chinese began se similar wooden stamps for making marks on paper. These small stamps gradually replaced by blocks large gh to print a complete picture. After block was carved, a damp sheet of r, placed over the inked surface, was ed by hand until a print was made. So essful were the Chinese with wood ks that they produced millions of copies aper money.

E INVENTION OF MOVABLE TYPE

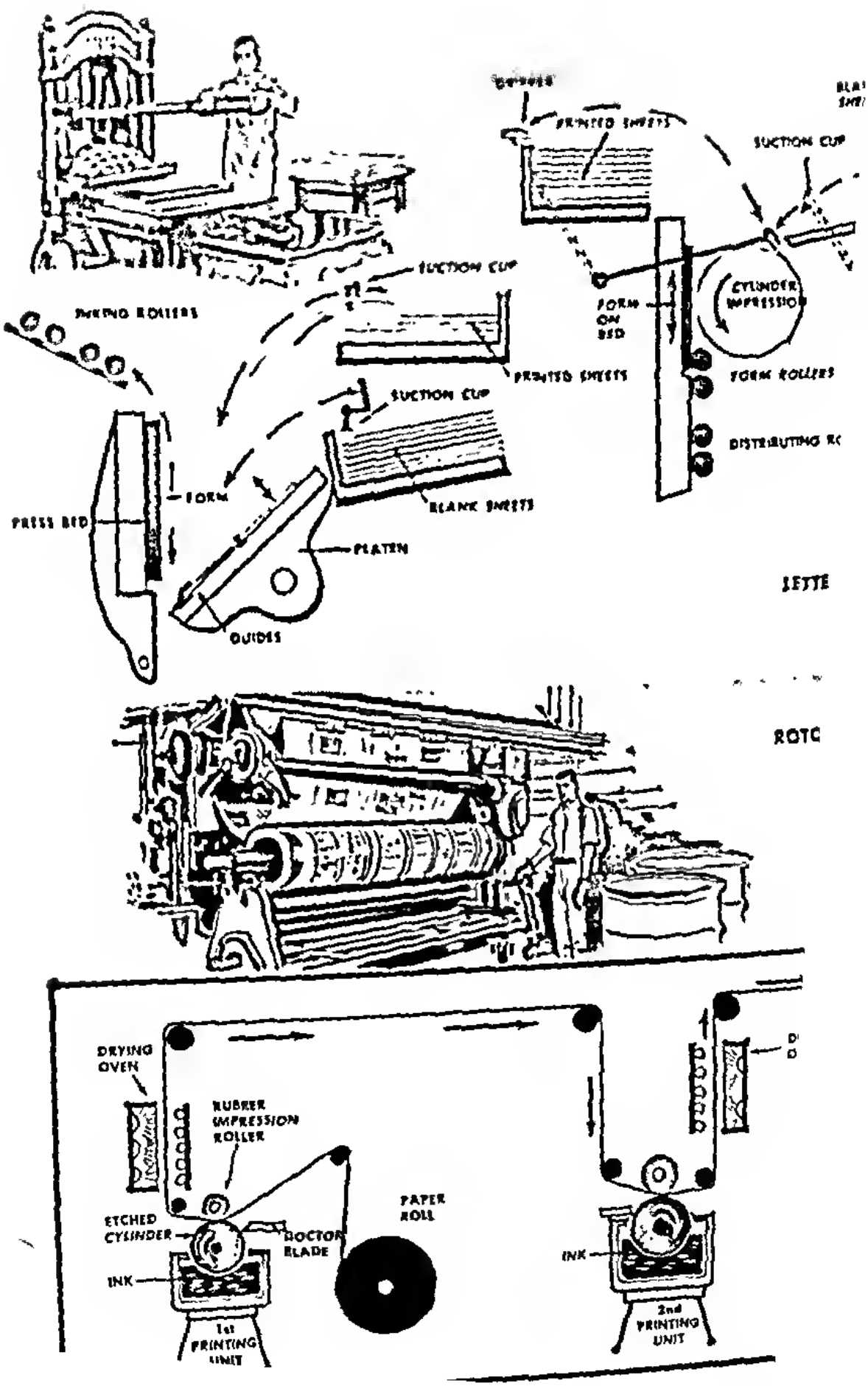
hen letters are formed separately, they be grouped into words, sentences, and graphs. They may be taken apart and sembled to form new words. Typewrit- have movable type. The individual let- may be used in any combination.

lock printing was an important step to invention of movable type. Although the individual letters could not be reused, the blocks produced identical ink prints. In the 11th century, the Chinese were again the first to print from movable type. They made individual letters out of baked clay, which were then assembled in a frame.

THE FIRST PRINTING PRESS

It is interesting to think that people wrote for almost 2000 years before they learned how to print by machine. In the middle of the 15th century, a goldsmith from Germany, Johannes Gutenberg put together the first workable press. Used originally for making wine, the press operated with a screw which brought together two flat surfaces. Each page of movable type, set by hand, was inked into a wooden frame, inked, and placed on the lower surface, or *printing bed*. After a sheet of paper was placed over the type, the upper surface was lowered by means of the screw. As the two surfaces came together, a print was made.

The press, which later became known as the *platen or flat bed press*, could produce about 300 pages a day. Although today's


SUCTION CUP
PRINTED SHEETS
SUCTION CUP
FORM ON BED
CYLINDER IMPRESSION
FORM ROLLERS
PRINTED SHEETS
SUCTION CUP
BLANK SHEETS
FORM
PRESS BED
PLATEN
GUIDES
DRYING OVEN
RUBBER IMPRESSION ROLLER
ETCHED CYLINDER
DOCTOR BLADE
INK
PAPER ROLL
INK
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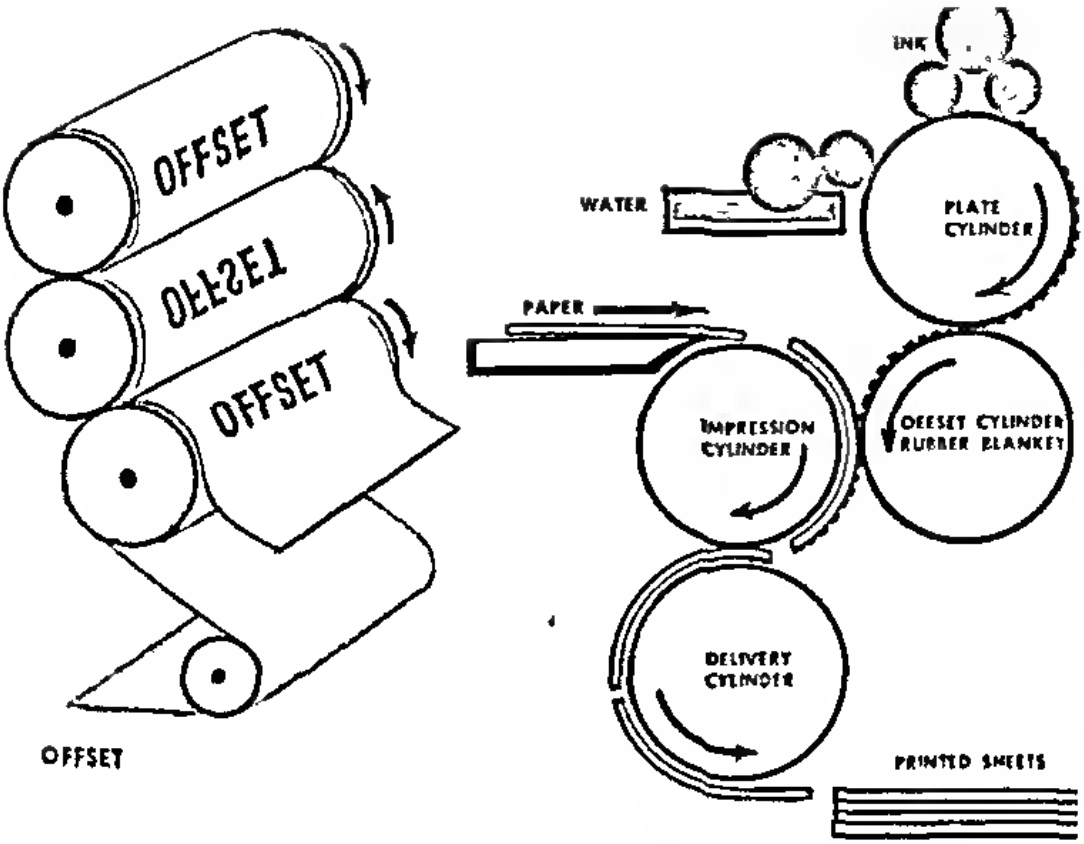


OFFSET

A large four-color offset lithography press as used in modern printing plants

would amount to about three or four copies of one magazine, the speed output was superior to either handwriting or hand printing.

With the advent of the industrial revolution, steam was used to drive the press. However, the press itself did not change for about 300 years. Not until 1813 did the first *cylinder press* appear. While the type remained on a flat bed, the paper was placed on a revolving cylinder, which moved from one end to the other, much as a rolling pin moves across dough.

The next problem facing the printers was how to place the type over the cylinder. Finally, the *stereotype*, a light-weight metal copy, or mold, of the type was invented. It was made by placing a sheet of moist cardboard over the type which was already set in the wooden frame. As great pressure was applied, the cardboard, forced against the type, made an impression, or mold, of the whole page. In shape, the cardboard mold was to the type what jelly mold is to jelly. By pouring a thin layer of hot lead alloy over the cardboard mold, a second stronger metal copy was made.

The sheets of type could now be bent to fit the curve of the cylinder. The *rotary press*, in which both type and paper moved over cylinders, was the next development.

Many improvements continued to be made. A machine called the *linotype*, which set and cast each line of type ready for printing, was patented in 1885. Finally the *camera* was used in printing. Pictures were transferred by chemical means, from photographic film to a metal printing plate.

Today, much printing is still done by hand. For mass production, commercial printing must be done on high-speed presses. In spite of the new and interesting techniques, there are still only three major methods of transferring ink to paper.

RELIEF PRINTING

Since block printing is a type of relief printing, this is the oldest process. The principle is simple. Like letters on a typewriter, those parts of the plate which print are raised. Those which do not print are below the surface. The largest volume of printed material is produced by this method, since it is used for printing newspapers, books, and magazines. Commercially it is known as *letterpress printing*.

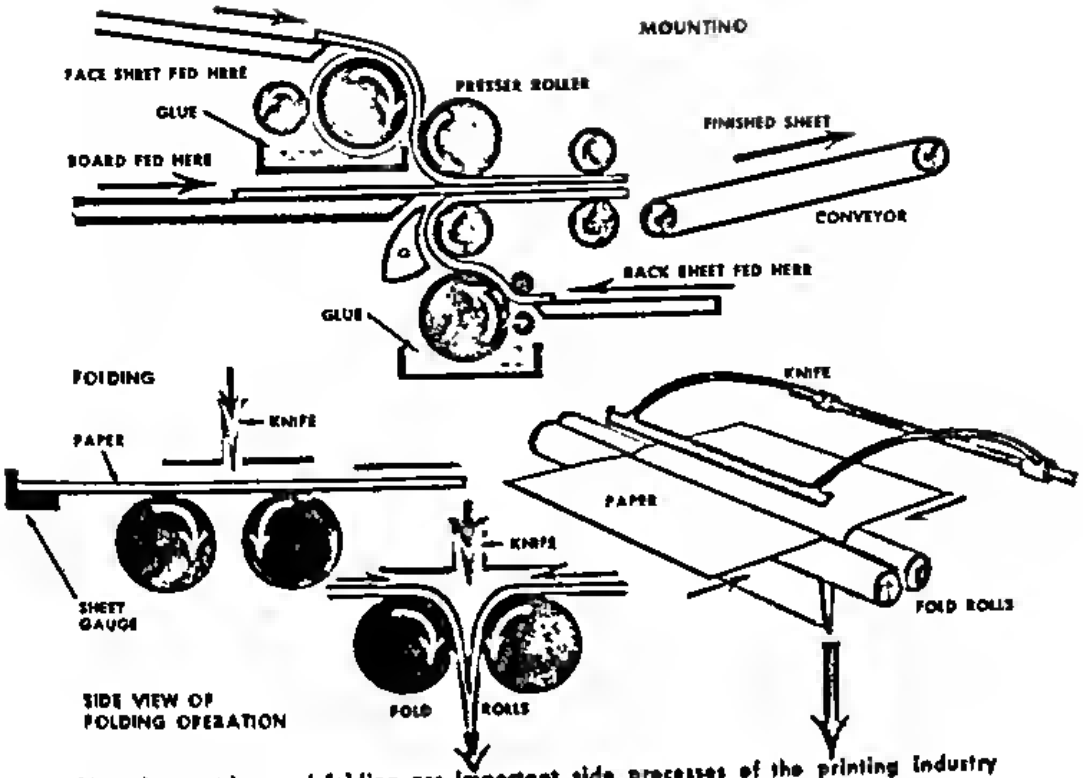
When a black and white picture is to printed, it is first photographed onto a gl plate and printed on a treated zinc pla just as a picture is photographed on fi and printed on paper. After being treat with chemicals, the parts which will n print are eaten away with acid, leavi those parts which will print raised.

But most pictures have light and da shadows. In order to print accurately shade areas, the *half-tone* process is used. One wh examines newspaper photographs, finds tha they are made of tiny dots, smaller in ligh areas and larger in dark areas. The pictur is photographed through a half-tone scree onto a treated metal plate. The screen con sists of two sheets of glass, having paralle diagonal lines, filled with black pigment These are placed face-to-face so that the lines are at right angles to one another, giving the effect of a window screen. The size of the dot varies with the amount of light striking the metal plate.

The most inexpensive color printing is the three-color process. Since any number of colors may be printed, the term is misleading. By making a separate plate for each color, the plates may be printed like the regular black and white plates. However, the colors are flat and less subtle than they are in other color processes.

The most expensive but most accurate color printing, the *four-color process*, is similar to the half-tone process. The picture to be printed is photographed through color filters and half-tone screens to produce four separate colors—red, yellow, blue, and black. Thus, the printer has four dotted plates. By printing these on top of one another, practically any color may be made.

In letterpress printing, after copy and pictures are assembled, a stereotype, or copy, of the entire page is made. The giant *rotary presses* used by big city "dailies" have printing cylinders which carry 4 or 8 of these plates. Each time the cylinder turns, it will print 4 or 8 pages on one side of the paper and 4 or 8 on the other side. The continuous webs or rolls of paper are pressed against the printing cylinder by means of a second, or impression, cylinder. One press may contain several of these units. Each unit can produce about 50,000 impressions an hour. Smaller printing firms may use cylinder or platen presses.



Mounting, cutting and folding are important side processes of the printing industry

PLANOGRAPHIC PRINTING

This method, one of the most recent, is based on the simple principle that grease and water will not mix. (Instead of being printed from a raised surface, both type and pictures are on a flat surface.)

Drawing or lettering was originally done on a thick porous stone with a crayon or ink mixed with tallow or wax. The surface of the stone was sponged with an acid, changing the surface not covered with wax into one which repelled grease and accepted water. The parts covered with wax accepted grease and repelled water. During printing, the stone was moistened with water, which soaked into those parts not drawn on. Printing ink, rolled over the surface, adhered only to the original drawing, which accepted ink.

Of course the heavy stone, still used in hand printing, is too awkward for commercial use. It has been replaced by a flexible, fine-textured *zinc* or *aluminum* plate. The image is photographed through a fine screen onto the plate. Since both text and pictures are printed from the same plate, the process is fast.

Commercially, planographic printing is called *offset lithography*, or *photo-offset*. Instead of printing directly on the paper, the metal plate prints on a third roller, which transfers the print to the paper. The elastic, rubber roller is able to pick up fine dots and transfer them to tough paper, metal, wood, or canvas.

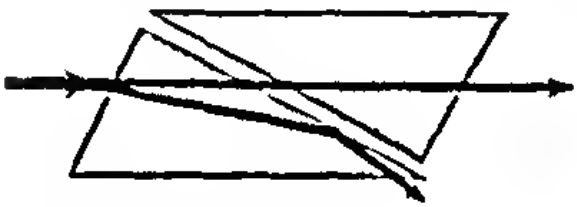
INTAGLIO PRINTING

In this process, both type and pictures are below the surface of the plate. Known before the time of Gutenberg, this method was called *engraving*. After the design or letters were cut into the steel or copper plate with a sharp V-shaped tool, the plate was covered with ink. Thus far, the process resembles block-printing. The entire surface wipes clean, however, so that the ink remained only in the lines. The plate, placed face down on a sheet of moist paper, was covered with felt and pressed with great pressure through a hand press. The ink was transferred to the paper by suction. The deeper the line, the darker the print.

Today this process is used for printing wedding invitations and certificates. The best known example is the printing of paper money and stamps by the Bureau of Engraving in Washington. The lines are severe, definite, and slightly raised.

Commercially, intaglio is known as *gravure printing—rotogravure* and *photogravure.* Pictures and words are reduced to small spots, which, instead of being raised above the surface as in relief printing, are small, square, microscopic wells below the surface. Although the cups are equal in size, they vary in depth. The deeper cups, which hold more ink, will transfer heavier deposits to the paper, thereby printing darker areas. Since the ink spreads over the paper, the dots overlap one another, giving a rich, velvety, slightly powdery quality. Big edition magazines, Sunday paper magazines and many high-quality art books are printed using the intaglio, or gravure printing, method. E. P. L.

SEE ALSO: COMMUNICATION, MACHINERY, PAPER, PHOTOGRAPHY



Polarization of light through a prism

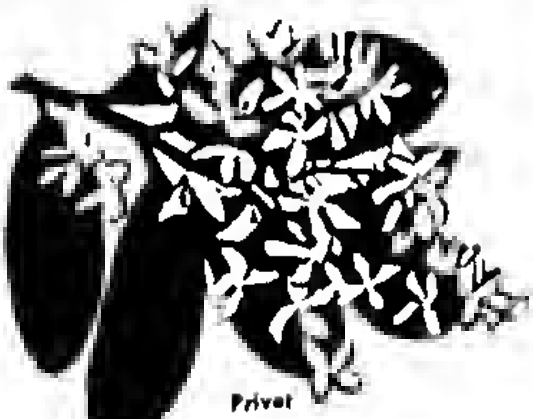
Prism In geometry, a prism is a solid object the sides of which are equal *polygons* and the ends equal and parallel polygons. Some prisms are given special names according to the shapes of their bases. Some of the most common shapes are *triangular, quadrangular and rhombic. These names* also apply to some crystal structures which grow in the shape of prisms.

Probably the most common use for prisms is in the study of optics. One of the most interesting and simple applications of a triangular glass prism is to the study of the different wave-lengths of light. If the prism is placed in a narrow beam of sunlight, the light will be bent as it passes through the prism. Not all of the colors will be bent in the same amount, however, so that a strip of colors will fall on a screen. This strip of colors is called the SPECTRUM and this method of producing it was discovered by Newton. The violet end of the spectrum is bent through a greater angle than the red end. The separation of the colors by this method is known as *dispersion.*

A rather specialized application of prisms in optics is the *polarization of light.* The prism employed in this process is called a *Nicol prism,* named after its inventor, W. Nicol. The prism is made of two pieces of calcite cut in a particular manner and cemented together with Canada balsam. Because the index of refraction of Canada balsam is between the indices of refraction for the two pieces of the prism, some of the light (extraordinary ray) passes through the prism and the rest of the light (ordinary ray) is reflected out the side. Hence, the light coming out the end is polarized. A. E. L.

SEE ALSO: LENS, MAN-MADE; LIGHT

Privet Privet is a shrub used in hedges. In summer it has small white *flowers,* and in the fall blue-black berries. Sometimes privet is clipped in odd shapes like arches and animal shapes. It is related to the lilac and the olive.



Privet

Probability Probability is a branch of MATHEMATICS which tries to determine which one of a number of events, all of which are the possible results of an act, is likely to occur, and how many times it is likely to occur.

Proboscis (pro-*BOS*-is) A proboscis is an elongation of the mouth, or an organ which protrudes in the area of the mouth. It may be the sucking organ of an insect or a grasping organ like the elephant's trunk.

Procyon (PROH-see-ahn) Procyon is a brilliant star which gets its name from the fact that it precedes the star *Sirius* in its nightly path across the heavens. Sirius is "the dog" and Procyon means "before the dog."

These two stars are called "dog stars" and are referred to in ancient literature. According to astrology, Procyon is the star that portends wealth, fame, and good luck.

Procyon, like the star SIRIUS, has a faint companion which is believed to be a white dwarf. V. V. N.

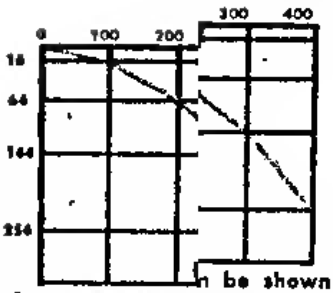
Progesterone (pro-JES-ter-own) Certain organic chemicals called *hormones* are necessary for the body to carry on its functions. Progesterone is one of the hormones that regulates the reproductive processes of the female. It circulates in the blood stream.

Progesterone is produced by the *corpus luteum*, a tissue of the OVARY which develops after ovulation. Under the influence of progesterone, the lining of the uterus becomes highly developed and prepared to receive a fertilized egg. The continuous production of progesterone during pregnancy keeps the uterus in the proper condition for the development of the *fetus* or child. J. R. S.

SEE ALSO: ENDOCRINE GLANDS, HORMONE, MENSTRUATION, REPRODUCTIVE SYSTEM

Projectile Any particle or body which has horizontal motion and at the same time acts like a falling body can be classified as a projectile. A stone hurled in a horizontal direction is a projectile. Rifle bullets and torpedoes are the most commonly used examples of projectiles.

It may seem a bit odd that the horizontal motion has no effect on the vertical motion or vice versa, but nevertheless this is true if air resistance is neglected. If a projectile is fired horizontally, it will have a *velocity* in that direction equal to that given it initially. At the same time it is traveling horizontally, it will fall toward earth, due to *gravitational* forces exerted on it. While the



The path of a projectile can be shown on a graph to have a curve as above when the initial velocity is 100 feet per second. The fall is due to the regular action of gravity

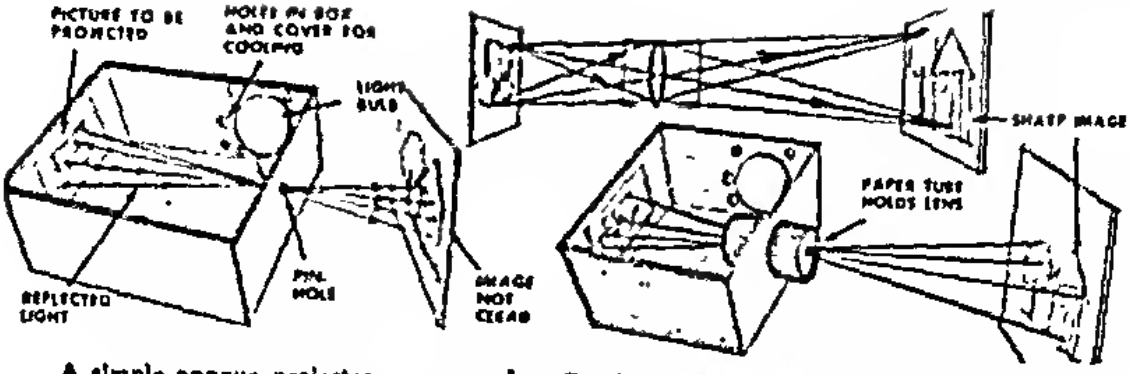
stant velocity, the horizontal motion is at *con*ted. vertical motion is accelera wing the path of

A simple method of sho series of equally a projectile is to draw a piece of paper. spaced vertical lines on a ese lines repre- The distance separating t the bullet. The sents the initial velocity o to represent the horizontal fines are drawn fall in each sec- distance the projectile will avity. These ond due to the action of g nd 256 feet tances are 16, 64, 144, 2 seconds, figu spectively for the first four where S is from the formula $S = \frac{1}{2}gt^2$ and t is the t distance, $g = 32$ ft./sec^2, he initial velo in seconds. A curve using ve. Other cur as 100 ft./sec appears abo itial velocities can be drawn using other in o influences

The earth's rotation als ullet is fired path of a projectile If a b sphere, it tra north in the Northern Heml the rotation east as well as north due t urface does the earth. (The earth's s arther north travel as fast, however, the l the target wo is from the equator.) Since int at which be farther north than the po ould fall to gun was fired, the bullet w Southern Her right of the target. In the to the left sin sphere the bullet would fall the gun if it the target rotates faster tha pointing north. A. E.

MAP-MAKI

Projection Projection in nting the su is the method of represe e other cele face of the earth, or som a cone, or tial body, on a cylinder, n is the *Me azimuth*. The best know the earth *cator* projection in which le, with presented as a rectang presented *parallels* and *meridians* re g at rig straight lines intersecti angles.



A simple opaque projector; a convex lens fitted to a tube will make a sharper picture

Projector A projector is an optical device which sends out a beam of light. The projector contains a very bright source of light. This light can be gathered and directed by mirrors and lenses. The beam of light can be made to carry an image to be viewed on a screen.

A simple projector throws an image of any small picture onto a table or other surface. A box, with ventilation holes on the sides should be big enough to hold a light bulb and the picture to be projected. The light that bounces off the picture will have a path from the box and through the projection hole.

From all parts of the picture, bounced light gets out the hole to strike a screen. An image will show on the screen faintly but rather clearly if the hole is small, and bright but very fuzzy if the hole is large. The viewing screen cannot be very far from the box.

This type is called an *opaque projector*. No light passes through the picture being used. A convex lens fitted into a tube so as to slide and focus at the correct distance from the picture will cast a better image.

A *lantern-slide* type projector requires that light rays pass through a picture. A partly-transparent slide is placed between the light and the projector opening. The image depends on how much light is blocked or colored by the pattern.

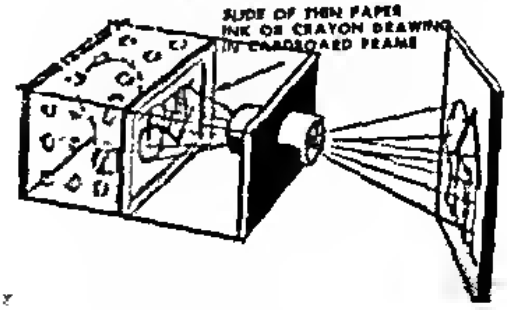
How far an image can be projected depends on the brightness of the light source. As light spreads out and covers more screen it becomes more faint. As distance is increased or, for example, doubled (two times as far), the brightness at the screen is one-fourth as much. If ten times as far, the brightness is only one hundredth. Projector bulbs are specially designed so that the filaments concentrate the source of light into a small area. A carbon ARC light is used in movie theatres.

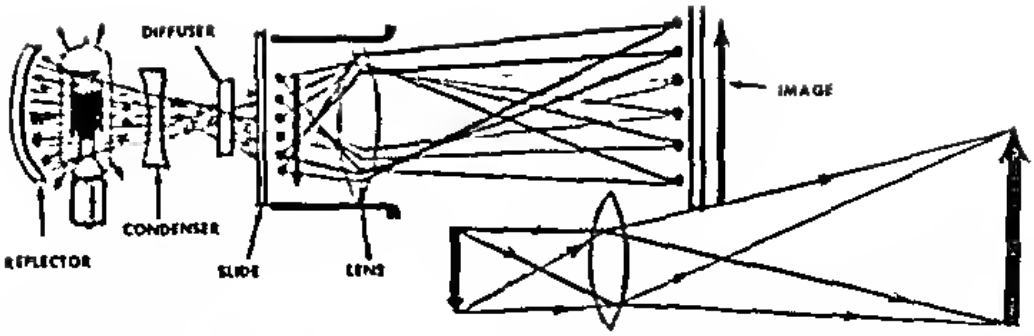
For either opaque or transparent slide projecting, it is important to gather as much light as possible. The more light that bounces off or passes through a picture the brighter the screen image will be. Great amounts of light must pass through a slide film, and it is necessary that the light hitting the film is spread uniformly. White frosted glass is used and called a *diffuser*. Lenses called *condensers* are also used to direct intense beams of light on the film.

The arrangement of lenses that do the final projecting is most important. The bright light that leaves the slide must be brought to a sharp focus. The diagram on the next page uses points of color as they might appear on a cross-section of a slide. It shows they end up on a screen arranged in the same pattern but as a reversed or backward image. Anyone who has threaded a movie projector or slide projector knows that the film piece is fed into the machine upside down and backwards so that it comes out right side up on the screen.

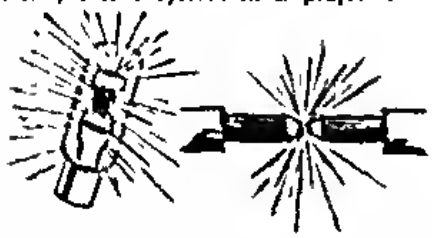
A movie projector rapidly places one picture slide after another between a light

A lantern-slide projector





A simple lens system in a projector



Projector light sources: bulb and carbon arc

source and a system of lenses. A shutter device flashes light just as the pictures come into position, or a special gear jerks the pictures along. A sound movie projector shows twenty-four pictures each second, but the eye sees each flash longer and blends the images together into a moving picture.

The index of refraction for any material varies with the wave-length of light passing through it. Thus, a lens forms an image at a different distance from the lens for each color. The lens in a projector is specially ground to minimize this effect. F. R. W.

SEE ALSO: LENS, MAN-MADE; MOTION PICTURES; PHOTOGRAPHY

Promethium (proh-MEETH-ee-um) Promethium is an element in the rare-earth metal group. Only recently discovered in atomic research, it does not occur naturally. It is considered to be a man-made element. Promethium was named for the Greek god, Prometheus, who is supposed to have given fire to man.

The element was identified in the material obtained by bombardment of stable NEODYMIUM with slow neutrons in atomic piles, and among the fission products of uranium. Two main isotopes of promethium are a mass number 147, with half-life of 2.6 years, and 149 with a half-life of 52 hours.

The symbol for promethium is Pm. It has an atomic number of 61. V. V. N.

SEE ALSO: ELEMENTS

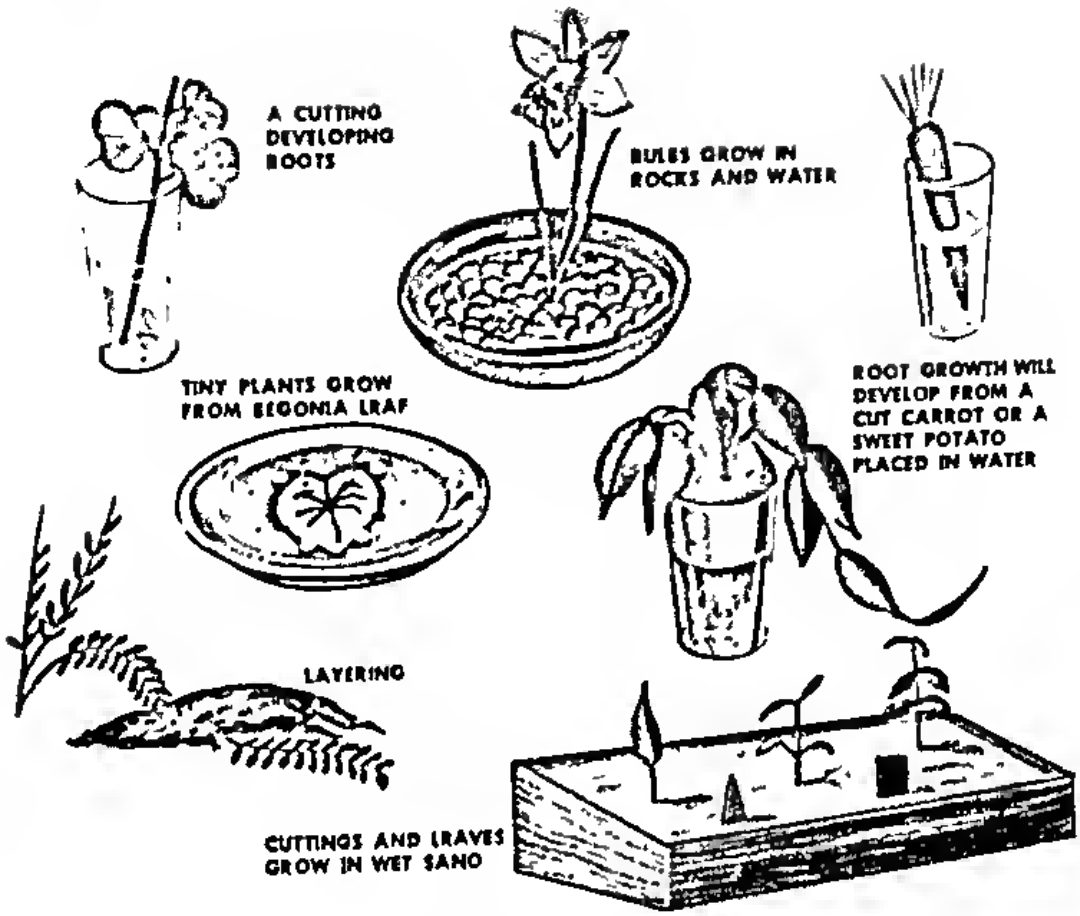
Pronghorn see Antelope, Deer family

Prop roots see Banyan, Pandanus

Propagation (prah-puh-GAY-shun) New plants are made from some part of the old plant. A seed will grow into a plant. When a sweet potato is planted in soil it will grow into a plant. A tulip bulb will grow a beautiful flower. A branch of pussy willow when placed in a glass of water will grow new roots. All of these ways that new plants are made are called propagation.

Plants vary as to which part is best for propagating the species. Most annuals are grown from *seed*. In some plants there are many underground stems which are used for propagation instead of the plant's seed. Tulips, daffodils, and onions are *bulbs*. The white potato is a *tuber*, while the sweet potato is a *root*. Iris and quack grass are propagated by *rhizomes*. Crocus and gladiolus have underground stems for propagation called *corms*. The strawberry plant sends a stem along the top of the ground. This runner takes root at certain intervals and starts growing a new plant.

Man has found it more economical and sometimes necessary to use parts of the plant to produce new ones. Banana and seedless fruits must be started from the *root stock* of the mother plant. *Dahlia*, *man-root*, and *mangel* are produced by *root propagation*. New house plants of *geranium*, *coleus*, *ivy*, and *philodendron* can be produced by *cuttings*. A stem from the old plant can be placed in a jar of water until new roots are formed from the cut end of the stem. The LEAVES from *jade*, *gloxinia*, and *sansevieria* may be placed in moist sand. The end of the *petiole* of the leaf will root and a new plant eventually appears. When cross cuts are made on the veins under a *begonia* leaf and pressed into wet sand, new plants will appear at each cut. Many flowering shrubs can be propagated by cutting a branch off and placing it in a jar of water.



Some home gardeners as well as nurserymen increase their shrub and woody vine supply by a method called *layering*. A branch of the existing plant is pulled over to ground level. At intervals along the branch, soil is piled over it. That part of the branch covered will root and send up a new shoot. When it is well established it can be cut from the original plant.

The propagating medium depends upon the species being produced. *Sand, mica* or *vermiculite*, and *sphagnum moss* are the most successful. Synthetic plant hormones are available. When these are added to the propagating medium they will speed up root growth. H. J. C.

Propane see Methane, Hydrocarbon

Propeller see Aircraft, Airplane

Prophase see Mitosis and meiosis

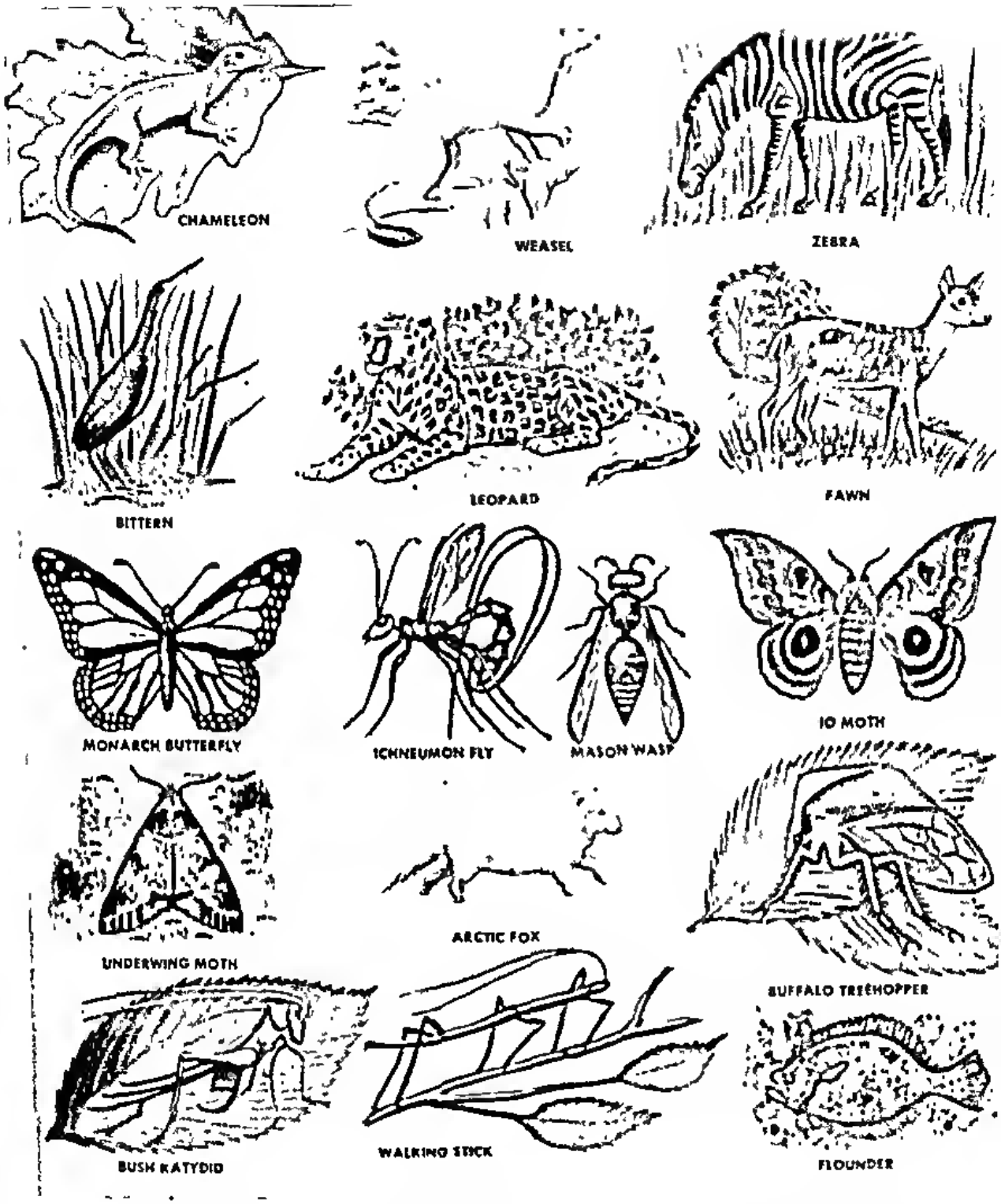
Proportion Proportion is a statement of equality between two ratios. A RATIO is the relation one quantity has to another. A proportion is written as $a : b = c : d$ or $\frac{a}{b} = \frac{c}{d}$; a and d are the extremes, and c and d are the means.

Prostate gland see Reproductive systems

Protactinium (proh-tack-TINN-ee-um) Protactinium is a radioactive element whose symbol is Pa. Protactinium has an atomic number of 91 and a mass number of 231. It is found in nature in all uranium ores, and occurs in such ore to the extent of about one-fourth part per million parts of uranium.

An efficient method for separating this element from its ore is a *carrier technique; zirconium phosphate* is precipitated from strong acid solutions, and consequently *precipitates*, or carries down, the solid protactinium with the zirconium salt. Then the protactinium is separated by crystallizing the zirconium as an *oxychloride*. V. V. N.

SEE ALSO: ELEMENTS



Protective coloration Protective coloration is the name given to the coloring of plants and animals which helps protect them from their enemies.

Animals are often the same color as the places where they live. *Green frogs* and SNAKES live in grass and weeds. They can hide from their enemies. In deserts, many *birds* and *reptiles* are sand-colored. Other animals, such as certain rabbits and weasels, are earth-colored during the warm months but change to white to blend with the winter's snow. In tropical regions,

brightly colored feathers of *birds* blend with the flowers of tropical plants. *Tropical fish* are often brightly colored when they live among corals and water plants. Small fish are almost transparent and, as a result, can remain hidden in water from their enemies.

The shapes of some insects resemble other objects in nature, and thereby serve as a protection. A *green katydid* resembles a *leaf*, both in color and shape. *Treehoppers* are small triangular-shaped insects which resemble *thorns*. The long slender body and angular legs of a PRAYING MANTIS resemble *twigs* of trees and shrubbery where it lives. *The stick caterpillar gets its name from its* habit of feeding by night and resting by day with its body stiff and stretched perpendicularly to a limb or twig.

Another type of protective coloration is known as "mimicry." Some animals having little means of protection resemble other living things which are feared by their enemies. For instance, moths *and flies cannot* sting, but some look like bees and wasps which have stingers. Another example is that of the *viceroy butterfly* which is eaten by birds. It closely resembles the *monarch butterfly that is distasteful to them.*

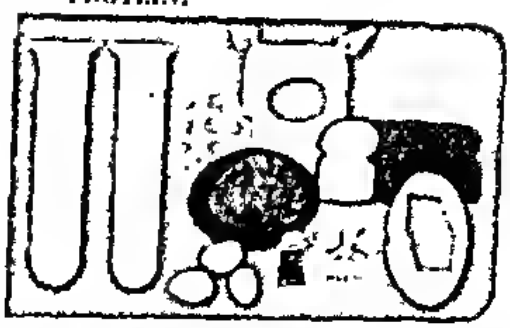
Cryptic or *ruptive* patterns are protective colorations which man has copied for *camouflage* in war-time tactics. Lines and stripes of color destroy the continuity of form, making it difficult to distinguish an animal's shape from his surroundings. The dappled shading on the back of a fawn blends into the leafy shadows.

Countershading is another type of protective coloration which is found on almost all animals. The back of the animal is darker than its underparts, preventing a dark shadow being cast under the belly. Such a shadow would draw attention to the animal, *making it easy prey for its enemies. All* fish have countershading. Even the areas beneath the beaks of birds are light in color in order to dispel shadows.

It is believed that, in past ages, living creatures *lacking protective coloration did* not survive. I. H. S.

SEE ALSO: CAMOUFLAGE, INSECTA, MIMICRY, TROPICAL FISH

WHICH FOODS ARE RICH IN PROTEIN?



1 *If a food containing protein is mixed* with lime and copper sulfate, the mixture will be violet colored.

2 Make two solutions and keep them separate until you add a little of each *to the food to be tested. Make solu*tion 1 by adding as much copper sulfate as the small amount of water you are using can hold. Make solution 2 by dissolving lime powder in water.

3 *Add equal parts of these two solu*tions to the food.

4 Is there protein in the following foods: hamburger, flour, butter, eggs, sugar, salt, cheese, and bread? Do some of *these appear to have more* protein than others?

Protein All living things are made up of cells. These cells are made up of protoplasm which is largely a mixture of proteins. The Greek word *proteios from which protein* is derived means "primary." These materials are of first or primary importance in living things.

Proteins are far more complex than most other substances. They are made up of smaller parts called *amino acids.* These giant molecules contain CARBON, HYDROGEN, OXYGEN, NITROGEN, and usually SULFUR. Albumin, a typical protein found in blood, has the formula of $C_{893}H_{1325}O_{200}N_{180}S_{18}$. *Protein molecules are too large* to pass through the walls of the intestine and blood vessels. They must be broken down into amino acids in digestion. The amino acids, which can be absorbed, are rebuilt into body protein in the cells.

Twenty-two amino acids are needed to *build tissues. Fourteen* of these can be made by the cells from FAT or SUGAR and nitrogen

which has been freed by the breakdown of used proteins. The human body needs to obtain eight different amino acids from food, but not all protein food contains all eight. Therefore a varied diet is necessary to insure adequate protein nutrition. Muscle cells contain the greatest proportion of proteins

All proteins are odorless and tasteless. Most are also colorless. They are very unstable compounds and undergo chemical change readily. Scientists often find it difficult to experiment with proteins because of their instability—the ease with which they break down. J. K. L.

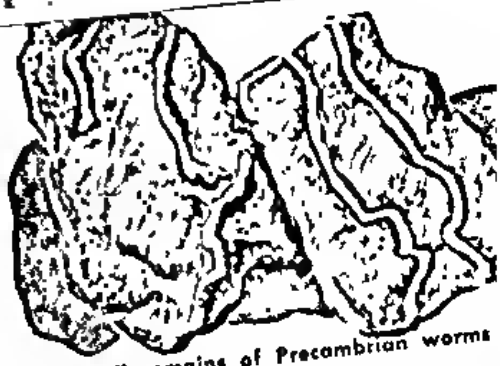
SEE ALSO: AMINO ACIDS, CARBOHYDRATES, NUTRITION, STARCHES

Proterozoic Era (proh-ter-uh-ZOH-ick) The Proterozoic Era (*proto* means "earlier" and *zoic* means "life") occurred from 1700 million years ago to 500 million years ago. It lasted 1200 million years.

The Proterozoic Era was part, along with the ARCHEOZOIC ERA, of the *Precambrian* period. Precambrian rocks of these eras include *igneous*, *sedimentary*, and *metamorphic* rocks. Signs of past life are most often found in the sedimentary rocks. Even in these rocks very few distinct proterozoic *fossils* have been found. The lime deposits of blue-green ALGAE are the only known plant fossils. Animal fossils are even more rare and less distinct. They include the *marine worms*, *jellyfish*, *sponges*, and *one-celled protozoans*. These plants and animals are all among the simplest forms of life.

These plants and animals were all marine forms. Apparently no life existed on land. Because remains of very simple marine life occur in the rocks of this time, one can conclude that there probably was a good deal of such life in the oceans. The lack of fossils can be explained by the fact that most forms were very small and lacked hard parts such as shells, bones, etc., that could be preserved as fossils.

During this part of the Precambrian period intensive *volcanism* and *diastrophism* (uplifting) occurred. It was, however, interrupted by long periods of *erosion* and *deposition*. There was also another very important event. The first recorded *Ice Age* of the earth's history took place in eastern



Fossil remains of Precambrian worms

Canada. Geologists know this because th *striated* boulders and other glacial dep as evidence of its occurrence

These mountain-building revolutions not sudden, short periods of upheavals are known to have been many millio years in length. V.

SEE ALSO: GEOLOGIC TIME TABLE

Proton (PRO-tawn) The prot one of the building blocks atomic nuclei. A proton is the n of a hydrogen atom. The protor positive charge equal to the n charge of an electron and 1836 times the mass of an el The proton was first identif Rutherford in 1919. Recent r has shown that the proton surrounded by a "cloud" of

The mass of a proton is 1.007 mass units (amu). The amu scal on assigning the lightest ISOTOPE a mass of 16.00000.

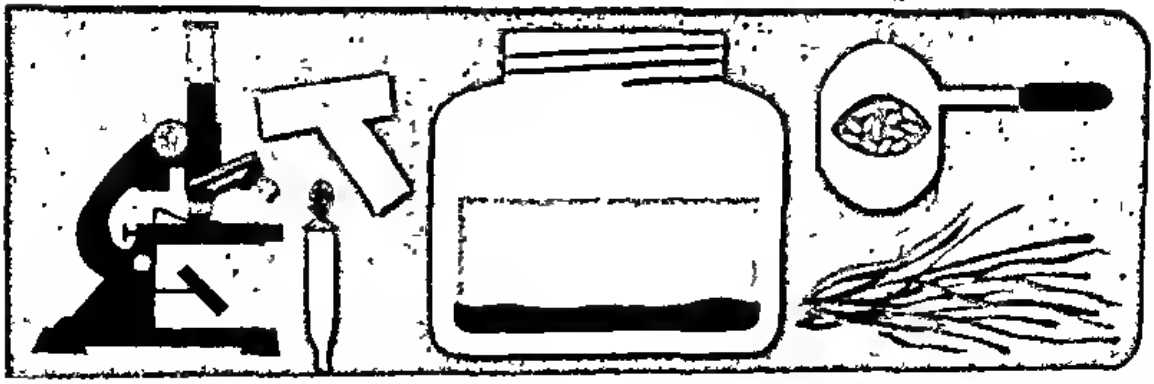
High energy protons are pr accelerators such as cyclotrons. nuclei of other atoms are bom protons, new elements are forr elements are often radioactive. energy protons have great power. A proton having an en million electron volts can pen than three feet of water. The p ally loses energy as it passes water. The average distance a p before all its energy is lost *range* of the proton.

Low energy protons in the f gen ions, H^+, are responsible properties of substances su chloric acid (HCl), sulfuric and acetic acid ($HC_2H_3O_2$).

SEE ALSO: ATOM, NUCLEAR

Proton number see Nu glossary

HOW MANY ANIMALS CAN YOU FIND IN A DROP OF WATER?



1 **One-celled animals are found in most fresh water, streams, ponds, lakes, or classroom aquariums.**

2 **Take a large jar along with you when collecting. Fill the jar with an inch of mud from the bottom of the pond and then half full of pond water. Break off a handful of dried hay or grass growing along the bank. Add this to your culture.**

3 **Cook up about a dozen grains of rice. This will serve as additional food. Permit the jar to stand for one week undisturbed. Do not put it in direct sunlight.**

4 **Put a drop of this protozoa culture on a slide and observe under a microscope. It will be teeming with one-celled animals, as well as minute water insects, and flatworms.**

Protoplasm Protoplasm is the general name for the material of which all plant and animal CELLS are made. It contains many large, specialized molecules (*macromolecules*).

Protozoa (proh-tuh-ZOH-uh) Protozoa means "first animal." Many scientists think that protozoa, or animals like them, were the first animals to live on the earth. They are classed as the first, or simplest, group of lower animals because their bodies are made of a single cell. They are called *unicellular* animals. *Uni* means one.

People are made up of many tiny cells which cannot be seen with the naked eye. For the same reason, most people have never seen protozoa. Most of them can be seen only under a microscope. If five of the largest were placed end to end, they would take up only one inch. It would take 25,000 of the smallest to measure one inch.

Even though each protozoan animal has only one cell, it takes in food, water, and oxygen. Protozoa build new materials for their cells and get rid of wastes. Like the larger animals with many cells, the protozoa are able to carry on all the activities that are necessary to stay alive.

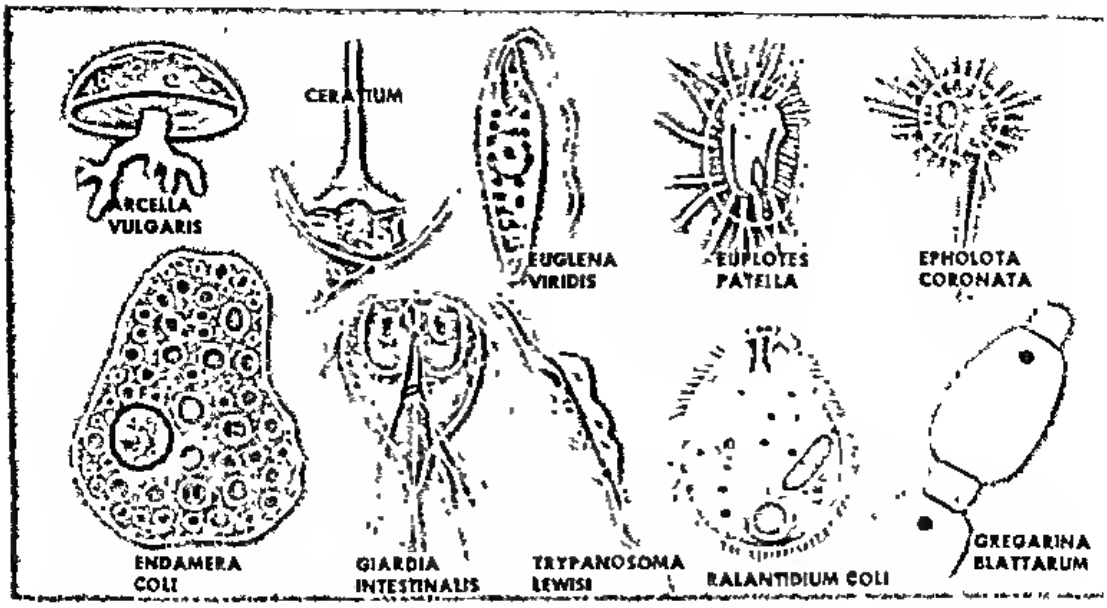
All protozoa live in water. They may, however, live in microscopic bits of water. Those which live in the dry desert sand need only the thin film of water found between particles of sand. These small creatures have neither limbs nor muscles to travel great distances. Nevertheless, they are carried all over the world by wind, water, and other animals.

MOVEMENT OF PROTOZOA

According to the way they move from place to place, the protozoa have been divided into five large groups or classes. The *flagellates*, or "whip-bearers," have one or more long flagella by which they swim. The flagella is a thin thread-like extension of the protoplasm, located at the front end of the body. As it is vibrated in a whip-like motion the animal is towed behind.

The *ameboid* protozoa are called the *Sarcodina* after the Greek word *sarcos*, meaning "flesh." These animals put out *pseudopods*, or false feet, which are only temporary extensions of the protoplasm. Thus their bodies are continually changing shape. Since some members, like the *rad-* *Limans*, are covered with shells, they must push the protoplasm through tiny holes in the shell.

The *ciliates* are a group of active protozoa which move by means of *cilia*, short hair-



Various protozoa with scientific names; top row are free-living, bottom are parasitic

like extensions of the protoplasm. By beating these rows of cilia, the animal is propelled much as a boat is rowed with oars.

Some members of the *Sporozoa* are enemies of man, since they cause such diseases as malaria and cattle fever. These protozoa have no particular type of locomotion because they are all parasitic. Instead, they rely upon water and animals to transport their spores, or offspring.

The *suctorians*, or sucking protozoa, make up a special class. Although the young move by means of cilia, the adults attach themselves permanently to a solid surface. Since they have a long stalk and sucking *tentacles*, they resemble a tiny plant.

HOW THEY EAT

The method of obtaining food ranges from plant-like to animal-like habits. Some of the flagellates are able to carry on photosynthesis like a green plant, since their bodies contain chlorophyll. They manufacture and store starch from the food in water and soil. Other protozoa, like the large carnivorous animals, chase their prey. Some feed upon both plants and animals. BACTERIA, ALGAE, wood particles, and other small animals are common foods.

Some protozoa, like *Paramecium*, have permanent mouths or surfaces for ingesting food. The ameboid protozoa, however, take in food at any point on their bodies. The protoplasm simply flows around the piece of food. Suctorians have a unique method of sucking up the protoplasm of their prey by means of their long tentacles. Most parasites and many flagellates have another method. They absorb foods which have already been broken down into simpler substances.

THE PARTS OF THE BODY

Although each species is different in structure, all protozoa consist of a mass of living protoplasm which is surrounded by a thin membrane. For protection, there is often a thick, outer cuticle. Some have beautiful calcium or glassy shells.

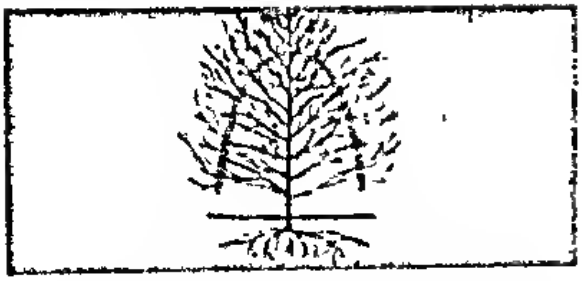
Perhaps the most conspicuous parts of the cell are the *nucleus*, *food vacuole*, and *contractile vacuoles*. The nucleus is the controller of the cell, regulating all chemical processes. From two to many hundreds of nuclei may be present. Food vacuoles, present only after eating, are large droplets of water containing food. Instead of food vacuoles, protozoa which photosynthesize food have pigment bodies containing chlorophyll. For collecting excess fluid from the protoplasm, one or more contractile vacuoles are present.

SELF-PRESERVATION

To protect themselves, to rest, or to reproduce, many protozoa surround their bodies with a thick-walled sac, or cyst. This is practiced among most parasitic protozoa, especially as they move from host to host. When environmental conditions are unfavorable in deserts, ponds, and marshes, this covering becomes necessary for survival.

While reproduction is sometimes sexual, most protozoa produce new animals by *asexual* means. Some develop buds which break off, while others divide one or more times in order to produce two or more daughter cells. F. P. L.

SEE ALSO: AMEBA; ANIMALS, CLASSIFICATION OF; CELLS; EUGLENA; EVOLUTION; MALARIA; PARAMECIUM; PARASITES; REPRODUCTION, ASEXUAL; STENTOR; VOLVOX



Shrub branches are pruned to increase bloom

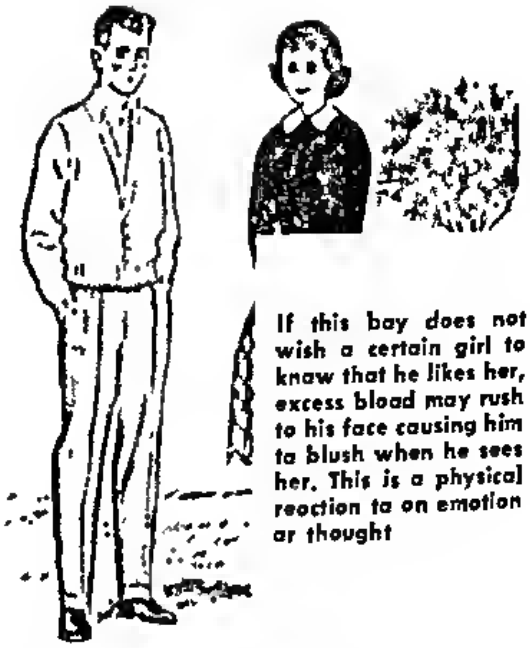
Prune (cut back) When parts of a plant are cut off for the purpose of improving the plant, this process is called *pruning*. Pruning of the stem, branches, shoots, or roots benefits the plant by improving the shape or increasing the size of the flowers and fruits. Plants may be pruned by natural means, such as wind, ice, snow, shade, and overloads of fruit. The pruned plant is smaller after pruning, but because of the pruning it becomes stronger and larger. The branches should be cut close and clean, and large cuts should be covered with a protective paint or wax.

Most deciduous trees require severe pruning for many years. If a tree has two main branches that form a sort of Y, there is a tendency for the tree to split when it gets older. The smaller branch should be removed, leaving only one main stem. Dead and diseased stems should always be removed. In spring-blooming shrubs and trees, the pruning should take place immediately after flowering. In late blooming shrubs and trees, pruning should be done only in the winter or very early spring. Hedges are pruned or sheared to keep them compact. Annuals and perennials are pruned by removing all but the strongest stems, or by pinching back the tops. M. R. L.

Prune (fruit) see Plum

Pseudopodia Pseudopodia are temporary extensions of the body of a one-celled animal such as the ameba. They make possible a flowing type of movement or engulfing of food.

· AMEBA, PROTOZOA

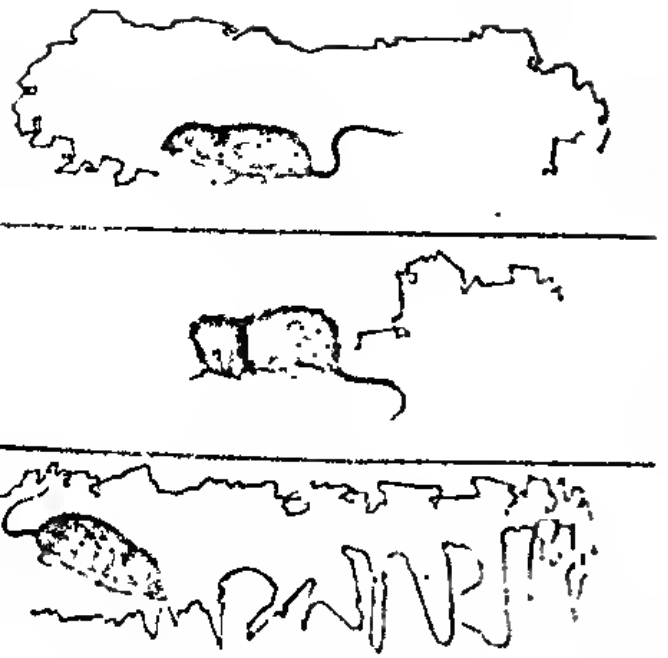


If this boy does not wish a certain girl to know that he likes her, excess blood may rush to his face causing him to blush when he sees her. This is a physical reaction to an emotion or thought

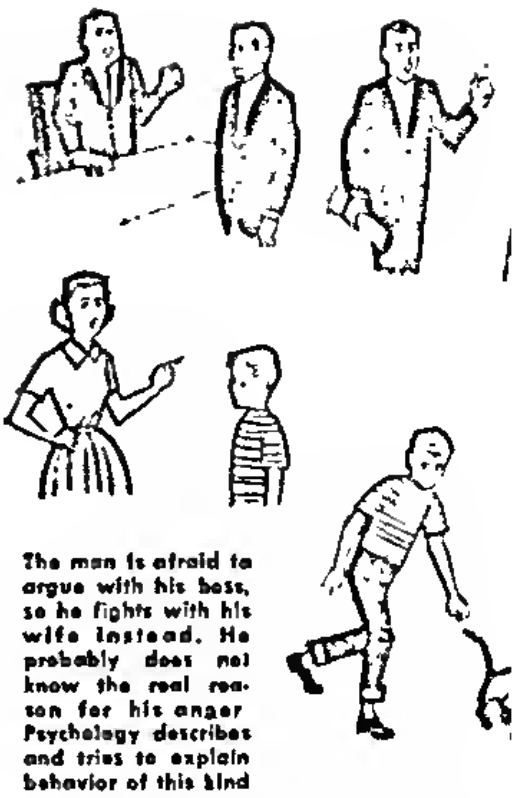
Psychology (sye-KAHL-uh-jee) Psychology is the scientific study of human and animal behavior. Like other sciences, it is concerned with research and application. Research finds out facts—in the case of psychology, facts about how people behave—and applied psychology uses these facts in schools, clinics, factories, and many other places.

As a science psychology is quite new. Of course people have always been interested in human behavior and have observed it and thought about it. Philosophy, theology, and literature have dealt with human behavior for centuries. Modern psychology differs from philosophy, theology, and literature because its method is scientific. Psychology proceeds by careful, objective observation, measurement, and experimentation.

Objective observation is illustrated by the studies made of the behavior of children in nursery schools. In such instances, various observers might watch the same child all morning and keep a record of everything the child did. When records by many different observers are brought together, the picture they present may be very different, and more accurate, than the observations of any one observer.



Certain kinds of behavior may be stimulated with drugs. The rat at the top shows its normal pattern of movement. In the middle, it has had a depressant drug; at the bottom, a stimulant one



The man is afraid to argue with his boss, so he fights with his wife instead. He probably does not know the real reason for his anger. Psychology describes and tries to explain behavior of this kind

Measurement usually involves testing a great many people and establishing a scale on which they can be rated. *Intelligence tests* and *achievement tests* are examples of psychological measurements.

Experimentation includes trying something out in a controlled situation—where one factor may be changed while all others are kept the same. For instance, the same group of workers who do the same kind of work in the same factory are given coffee breaks in the morning and afternoon for one week. The next week the workers are not given coffee breaks. Such an experiment is designed to find out whether or not the men work better if they have short, frequent rests.

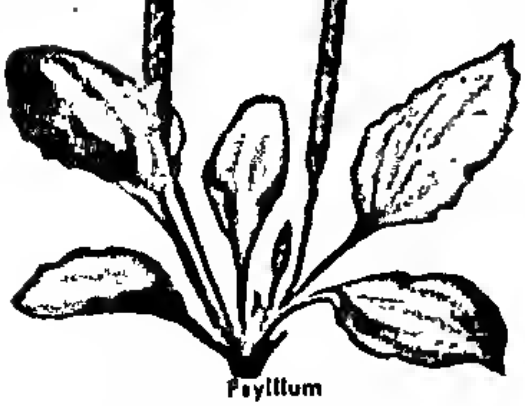
The knowledge gained in research is applied in many fields. Studies of how people learn most effectively are applied in education. Industry uses *aptitude tests* to place people in the kind of jobs they can do best. Studies of how people get along together in groups are used in business and industrial, as well as in educational and social, organizations. Clinical psychologists help people with problems.

A *psychologist* usually has a master's or a doctor's degree in psychology. A *psychiatrist* must have a degree from a medical school, as well as some training in psychology. A *psychoanalyst* must be trained in the method of psychoanalysis.

Since Wilhelm Wundt founded the fi psychological laboratory in Germany 1879, psychology has come to be regard as one of the *behavioral* sciences, along wi other sciences such as sociology, history, a political science. Each of these sciences h to find its own ways to observe, measure a experiment—procedures of investigatic which are different from the methods of t physical sciences. In searching for metho to understand human behavior, psychologis have moved in different directions. These d rections are represented by what are calle "schools" of psychology. SIGMUND FREU for instance, presented a new direction f study when he observed that there is an *u conscious*, as well as *conscious*, activity the mind. But whereas Freud felt behavi was greatly determined by the way man allowed to express his creative and destru tive instincts, J. B. Watson proposed th behavior is the result of physiological rea tion to external stimuli. Other fields of psy chology include educational psychology opened by Froebel and Pestalozzi, soci psychology, developed by William McDou gall and Havelock Ellis; and there exist man others, such as child psychology, ab normal psychology, individual psychology, and even animal psychology.

D. A. A.

SEE ALSO: NERVOUS SYSTEM, PAVLOV, REFLEX; SCIENTIFIC METHOD, STATISTICS, STIMULUS



Psyllium

Psyllium (SIL-e-yum) Psyllium is an annual herb found in Europe and India. It produces grasslike leaves, small flowers, and seeds which are used as a mild laxative.

Ptarmigan see Grouse

Pterodactyl (ter-uh-DACK-tihl) The pterodactyl was a flying reptile which lived more than a million years ago. Although it could fly, it was not a bird. It had certain features similar to birds, but basically it was a reptile.

The pterodactyl belonged to a group of reptiles which lived during the MESOZOIC ERA when the great reptiles roamed the earth. The flying reptiles are referred to as *pterosaurs*, a word made from the Greek word *pteron* meaning "wing" and *sauros*, "lizard." These pterosaurs had forelimbs or arm-like parts adapted for flying or gliding instead of walking. Their bones were hollow as are the similar bones of birds today. They had no feathers, however. The wings were formed of a leathery membrane extending from n foreleg finger to the body, probably similar to that of the modern bat. The pterodactyl's hind legs were long and slender; its tail was generally short.

Pterodactyls ranged in size from those with one-foot wingspreads to the large *Pteranodon*, with a twenty-foot wingspread. It had a two-foot skull, no teeth, and a short tail. All forms are extinct today. D. J. I.

SEE ALSO: BIRD, DINOSAUR, REPTILIA

Pteranodon, the largest of the pterodactyls

Ptolemy (TAHL-uh-mee) (127-151) Ptolemy (Claudius Ptolemaeus) was a noted Greek astronomer, geographer, and mathematician who lived in the second century A.D. He is best known for his system of astronomy, the *Ptolemaic System*, which declared the earth to be the center of the universe. His theory of the universe was believed by most people to be true until NICOLAUS COPERNICUS, a Polish monk, proved in the sixteenth century that the sun, and not the earth, is the center of the solar system.

Almost nothing is known about the life of Ptolemy. It is generally believed that he was born at Ptolemaius Hermii, a Grecian city in Egypt. The period of his life is estimated from the dates of his astronomical observations. It is believed that he made his observations and wrote in Alexandria.

The most important of Ptolemy's works was the *Almagest*, a thirteen-volume abstract of the astronomical science of the Alexandrian Greeks. In it Ptolemy explained his system of astronomy, giving Hipparchus credit as his chief authority. The system Ptolemy advanced was one in which the earth was a motionless globe. Around it revolved a spherical transparent shell in which were located forty-eight constellations and seven planets: the Moon, Mercury, Venus, the Sun, Mars, Jupiter, and Saturn. While making his observations, he discovered the irregular motion of the moon in orbit called *evection*.

Although Ptolemy is thought to have studied mathematics to make his astronomical observations more meaningful, his mathematical discoveries proved to be of greater value than those in astronomy. By explaining the mathematical theories of Hipparchus, he is considered by some to be the founder of *plane* and *spherical trigonometry*.

As a geographer, Ptolemy was almost entirely in error. He did, however, summarize all that the ancient world knew about the surface features of the earth. His main contribution to geography was an eight-volume *Guide to Geography*, the earliest effort to treat geography scientifically. He did not mention climate, natural resources, people,

or unique physical features of the countries with which he dealt. His map of the world and his twenty-six colored maps showed knowledge quite in advance of his time. The *Guide* greatly influenced the future study of geography. D. H. J.

SEE ALSO: ASTRONOMY, SOLAR SYSTEM

Ptomaine (TOH-mayn) Ptomaine is a word derived from the Greek word *ptoma* meaning "corpse." It is a term applied to substances (organic bases) which are formed by the action of bacteria on animal or plant matter, causing decay.

It is a compound containing nitrogen, produced by the putrefaction of proteins. Most ptomaines are harmless, but a few may be poisonous.

For a long time it was believed that the intestinal disturbance known as ptomaine poisoning was caused by eating food containing ptomaines. It has been established by medical authorities that this is not so, but that food poisoning is caused by specific bacterial poisons in spoiled food. W. J. K.

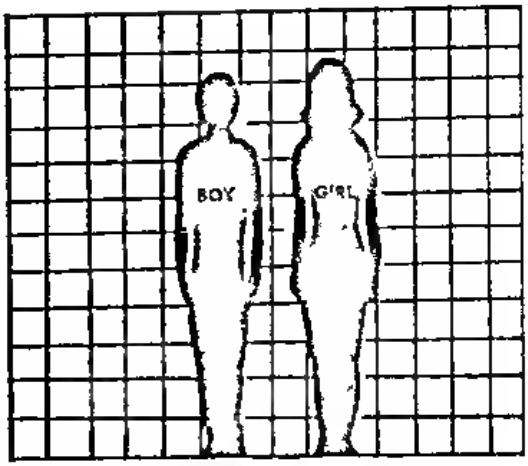
Puberty (PYOO-ber-tee) At about the age of twelve in girls and thirteen in boys, puberty or *adolescence* starts. The child is rapidly growing to be an adult. Among some people and in some religious groups, there are ceremonies to honor this new stage of human growth.

The word puberty is from the Latin *pubes*, meaning citizen. Today the word is narrowed to refer to the young person's beginning sexual and social maturity.

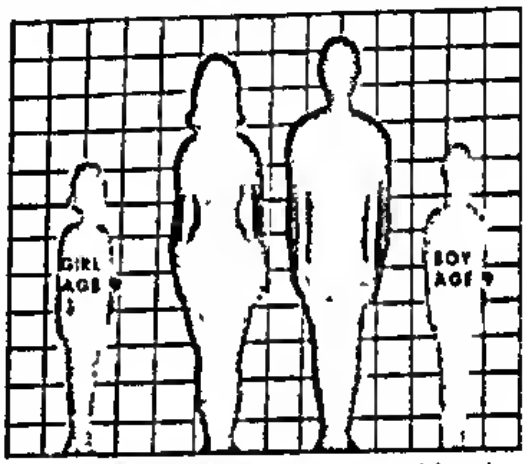
With the onset of puberty, bodily changes called *secondary sexual characteristics* gradually appear. In both boys and girls the sexual organs start maturing; sweat glands become more active; and hair commences to grow in the *axillary* regions (armpits) and *pubic* regions.

In boys the voluntary muscles develop more than in girls, and the shoulder bones broaden. The boy's voice deepens—often "cracking," and hair gradually grows on his chin and cheeks.

In girls starting puberty, the pelvic bones grow broader, the breasts start maturing,



At twelve years, the girl is larger and more mature than the boy



At fifteen the boy is usually larger and heavier than the girl. Adult body characteristics have begun to appear

and an even layer of fat tissue forms and rounds the outlines of the body. The teenage girl's voice enriches to the feminine ranges from contralto to high soprano. The monthly cycle of MENSTRUATION also starts.

Accompanying these bodily changes are complex changes in the emotional sensitivities of adolescent boys and girls. Changes of mental outlook vary from those of a new excitement about the world and a heightened appreciation of human beings to spells of independence and severe criticism of that world. Adolescents are helped through the changes of puberty by the good example and guidance of parents and other strong adult leaders whom they can admire. D. A. B.

SEE ALSO: HORMONES, PITUITARY, REPRODUCTIVE SYSTEMS, SEX

Puff adder see Snakes

Puffin

Puffin Puffin is a seabird of the AUK family. It has black-and-white plumage, a ducklike body, and short legs which make walking difficult. It is noted for its large, brightly-colored, triangular beak.

SEE: BIRD

Pulley see Machines, simple

Pulse The pulse is a rhythmic beat felt in any artery close to the skin. The contraction of the heart forces blood into the arteries, the arteries expand, and this expansion can be felt as beating or throbbing.

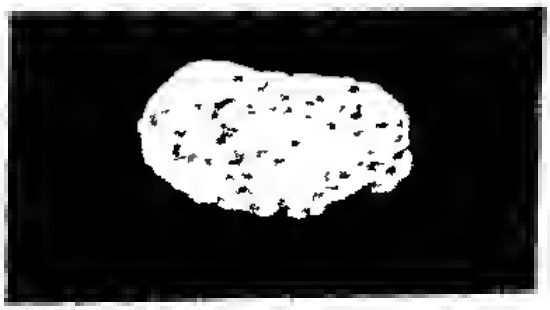
SEE: ARTERY, BLOOD, BLOOD PRESSURE, CIRCULATORY SYSTEM

Puma see Cat family

Pumice Pumice is hardened, frothy volcanic LAVA which has a high glass content. It is light enough to float on water. It is used in solid or powdered form as an ABRASIVE. It is a very porous rock.

SEE: ROCKS

Pumice is a light porous volcanic rock



Pump A pump is a machine made to raise or move liquids or gases by suction or pressure.

Pumps serve many purposes. In rural areas, hand or electric-powered pumps lift water from a well. A pump removes water from washing machines. Pumps circulate water, gasoline, and oil within an automobile engine. Large electric pumps force water to houses in the city. Oil, gasoline, and natural gas are transported hundreds of miles through pipe lines by means of pumps. The animal heart is a very important pump.

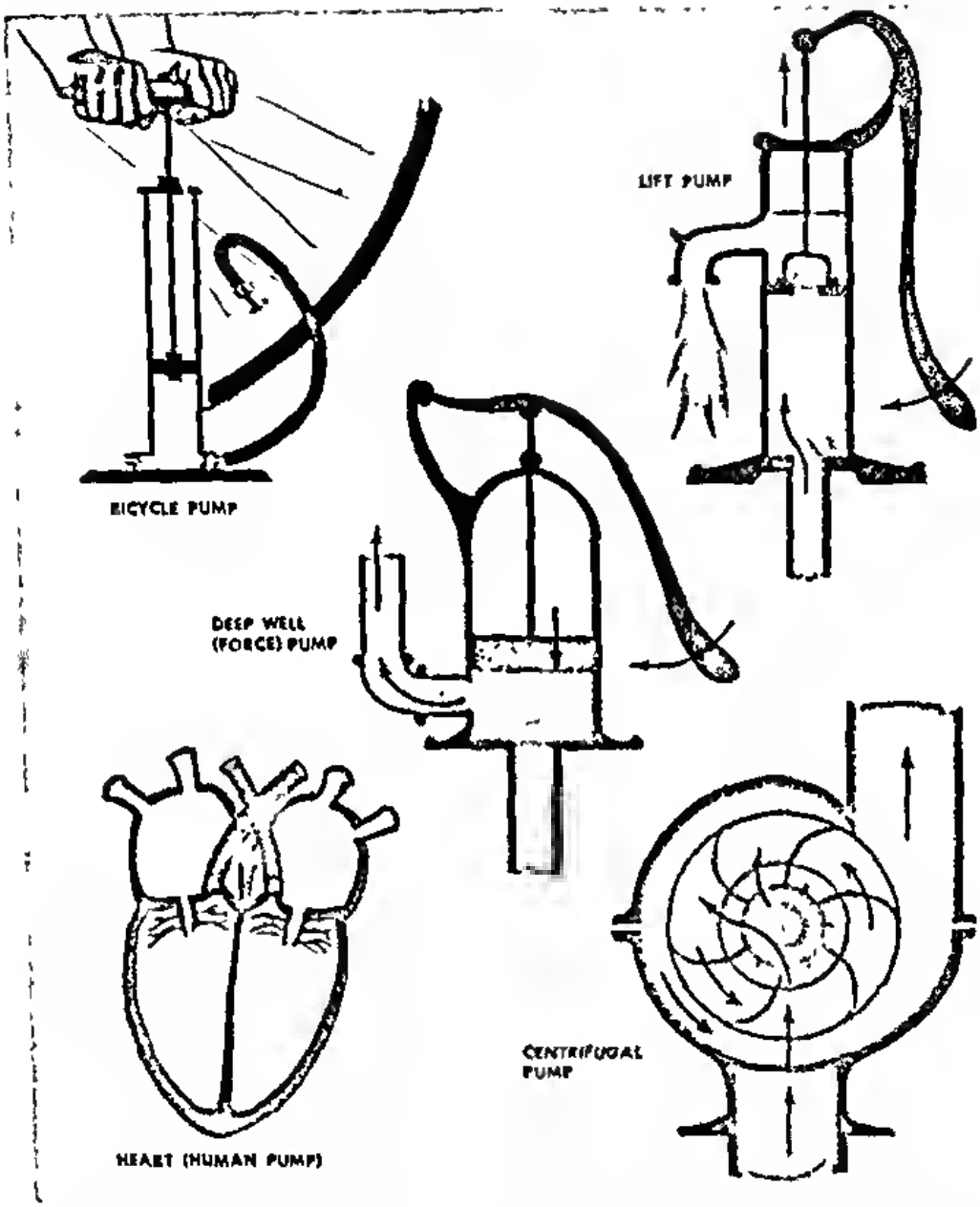
One of the earliest known pumps was the Egyptian "chain of pots." This pump obtained water from the Nile river. Romans used pumps in connection with their skillfully-developed aqueduct and city water system.

Today, many types of pumps perform various jobs. Basically, pumps fall into three classifications: (1) *suction* or *reciprocating* pumps, including lift pumps, (2) *force pumps*, and (3) *centrifugal pumps*.

The suction pump is often found on farms. It consists of a piston which fits air-tight into a barrel or tube. On the piston, a valve opens upward. A handle is attached to a rod, and, in turn, the rod moves the piston up and down. At the bottom of the tube is another valve which also opens upward. When the handle moves the piston downward, the air in the tube is pushed out through the valve on the piston. When the piston is moved upward, gravity closes this valve and produces a partial VACUUM above the water in the bottom of the tube. The water is forced upward into the tube by the pressure of the air on the surface of the water in the well. After a few strokes of the handle, the tube is filled and water flows out the spout. Since it depends on air pressure, it can lift water only to a height equal to that pressure, about thirty-two feet.

A lift pump is a variety of the common suction pump. This type of pump is placed at the bottom of a well. It robs less upon the efficiency of its suction, but relies more on mechanically lifting water.

The force pump has no valve at the piston



but rather has a valve at the spout or delivery tube. This type of pump is used in deep wells and by fire engines. It works independently of air pressure. Force pumps are usually run by electric or gasoline engines.

A *mercury vapor* pump uses mercury as a piston. By removing mercury from a bulb or tube, a vacuum is created. Early light bulbs had air removed from them by this type of pump.

Centrifugal pumps are employed for removing a large quantity of water or other liquid, provided the lift is not great. Generally, a centrifugal pump consists of a fan-shaped *impeller*, or blade. Inlets lead from the pump's center to its outer edge. An outlet is located on the edge of the pump. The impeller rotates rapidly, thus pumping the water by centrifugal force to the outlet. Washing machines use centrifugal pumps to pump out water. Modern water and sewage plants use this type of pump. P. F. D.

SEE ALSO: WELL

Pumpkin and vine

Pumpkin The fruit of the annual pumpkin plant is large and fleshy. The leaves are broad and lobed. The climbing stem develops tendrils that curl around things.

Insects carry the pollen from the male flower to the female flower. The resulting edible berry-like fruit is often called a *pepo*.

Pumpkin seeds may be fried and salted for eating, and the field pumpkin is used for cattle feed. The pie pumpkin is usually made from *Cucurbita maxima*, a squash plant. Both pumpkin and squash are in the gourd family. H. J. C.

Pupa see Metamorphosis

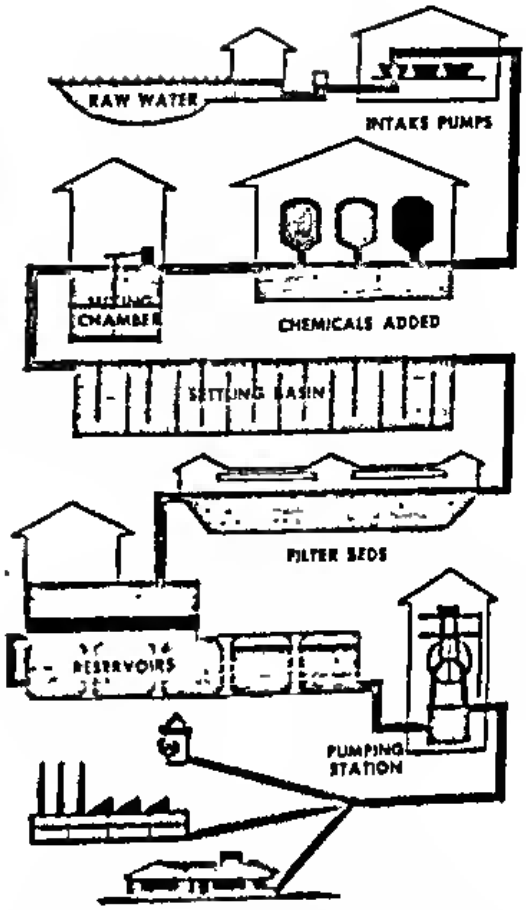
Pupil see Eye

Pure culture see Bacteriology

Purification Over the years, drinking water has been the most serious source of epidemic diseases. Many of the illnesses were traced directly to water that was not pure. Fortunately, the public water supplies today, particularly in the communities of this country, are well cared for. One rarely even gives thought to the safety of the water he uses.

Although purification is expensive, everyone should realize how important it is to protect and safeguard the water supplies. Whenever a community becomes careless about water, the threat of an epidemic of typhoid fever or other diseases may become serious.

Water supplies can be divided into two general groups: surface and underground. Surface-water supplies come from streams and lakes. Water from these sources is not considered safe unless it has been purified. Underground water supplies are obtained



from springs and drilled wells. This water is usually safe provided it has not been contaminated with surface water or by drainage. This type of water supply should be tested periodically.

The water supplies of large communities are usually from lakes and streams, and therefore, it must go through a purification process. Two factors should be considered to make water fit for human consumption. First, the dissolved organic matter should be removed. Second, the bacteria must be destroyed. Almost all towns and cities use one or more of the following methods.

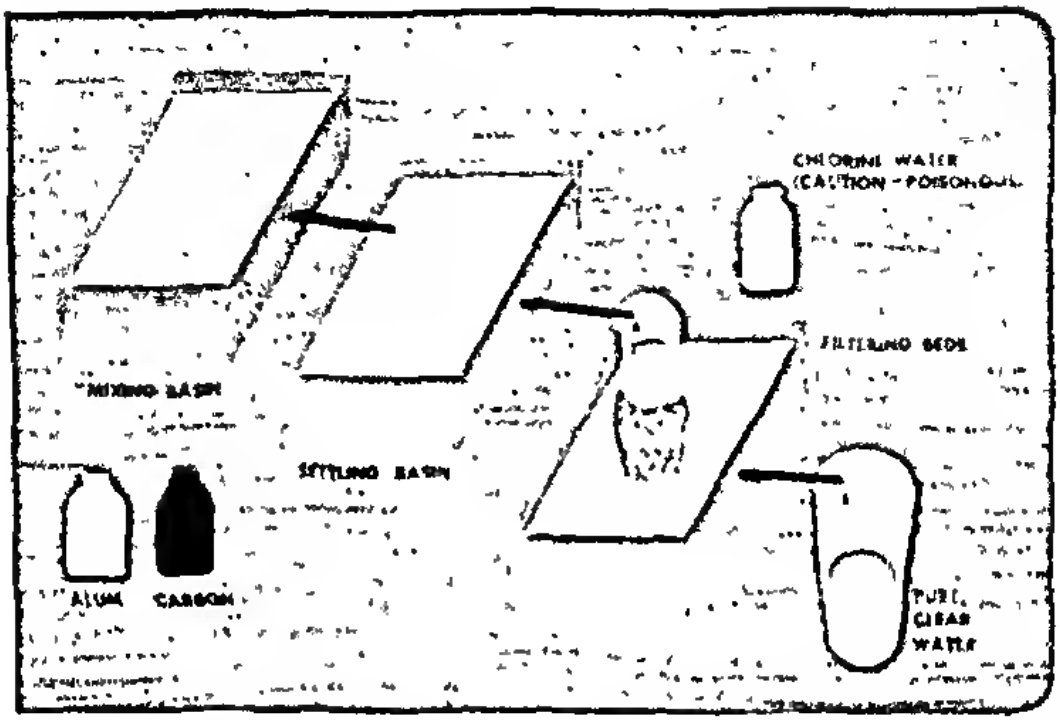
Settling: Water flows slowly into tanks, reservoirs, or basins. It is here that the organic matter sinks slowly to the bottom. Then the water is allowed to flow off on the opposite side of the settling basin from which it entered.

Chemicals: Particles of organic matter will settle more rapidly if certain chemicals such as alum are added to the settling tanks.

Filtration: Water is allowed to settle slowly through layers of sand, gravel, or charcoal. It loses much of its organic mat-

✳ THINGS TO DO

SETTING UP A FILTERING PLANT



1 Raw lake or river water must be treated before it is safe to drink. A model waterworks plant may be assembled by following the illustration.

2 Metal pans may be used for the mixing and settling basins. A glass chimney is suitable for the filtering bed. You will need to purchase alum which helps to clump the foreign particles and algae in the water to hasten the settling action. Carbon removes the fishy odors often found in water. Put a piece of gauze over the lower opening of the chimney. Add a layer of small pebbles on the bottom, then a layer of coarse sand, and finally fine sand. In water plants, a small amount of chlorine (poisonous) is added to kill the bacteria.

3 The final product should be clean clear water safe for drinking but since your model is on such a small scale it probably will not do a very efficient job.

ter in this way and leaves as clear water

Aeration: In many reservoirs, fountains force water up into the air. Here oxygen is dissolved in water and the flat taste is improved. Germs that are present are killed by the sunlight.

Chlorination: The gas chlorine is one of the most effective chemicals used to kill bacteria. It is used extensively in water purification. Many cities add this chemical to their water supply regularly, while others do so only when the bacteria count is higher than safety allows.

Bacteriological and chemical tests are run constantly so that people living in a large city can be sure that the water supply is healthful and safe.

Travelers and campers sometimes must use water they cannot be sure is safe for drinking. This water can be made safe by boiling it for a few minutes or by treating it with *bleaching powder* or *chlorinated lime*. Boiling water drives off the dissolved air. This results in the water having a flat taste. Air can be restored by shaking the container, or by a period of exposure to the open air.

Purr see Cat family

Pussy willows with catkins

Purine (PYOOR-een) Purines are organic compounds which contain *nitrogen*. Purines are contained in *nucleic acids*. The NUCLEIC ACIDS are important building blocks of the body. Adenine and guanine are two of the purines contained in *ribonucleic acid* (RNA), a chemical active in heredity.

There are many known purines, but only twelve have been isolated from natural sources. The purine, *caffeine*, comes from the coffee bean and tea leaves, and thus is present in coffee and tea. Caffeine is used in the manufacture of cola drinks. Another purine, *theobromine*, is found in the leaves of the cacao. These purines give the stimulating effects peculiar to these drinks. *Uric acid* is also a purine. J. R. S.

SEE ALSO: NUCLEOPROTEINS

Pus Pus is a semi-solid, yellowish discharge which appears at the site of an INFECTION. It is composed of dead *leucocytes, lymph, microorganisms*, and other debris.

Pussy willow Pussy willow is a large bush of the WILLOW family. Early in the spring buds all along its long straight branches open and flowers appear which are called *catkins*. They are furry grayish-white clusters that look like kittens climbing the branches.

Leaves appear after the pussy willow flowers. They are smooth and long, bright green above and gray underneath. The catkins develop into larger clusters and are covered with yellow pollen and then form seeds or drop off the bush.

Pussy willows grow wild in low, wet spots, sometimes reaching twenty-five feet. They are planted to beautify a place and to attract songbirds. P. G. R.

Putty Putty is a mixture of powdered natural chalk (*whiting*), linseed oil, and sometimes a small amount of white lead. It is used to fill holes in surfaces to be painted and to hold glass in frames.

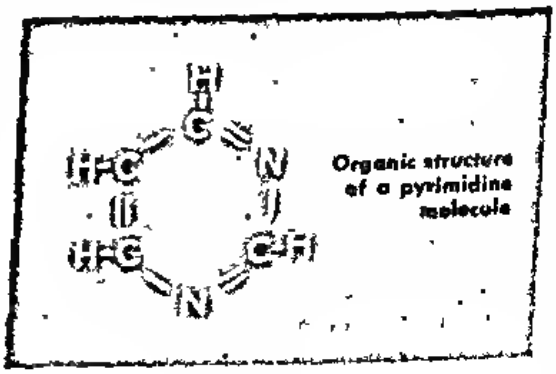
Pylorus see Digestive system

Pyramid see Geometry

Pyridoxine see Vitamin

Pyrimidines (pi-RIM-ih-dens) Pyrimidines are important parts of living material. Vitamins B_1 and B_2 contain pyrimidines. Pyrimidines are organic compounds which contain nitrogen.

Pyrimidines have been found to be important in determining traits which are inherited. The genes which determine traits like eye color contain NUCLEIC ACIDS. *Uracil, thymine*, and *cytosine* are found in the



Organic structure of a pyrimidine molecule

nucleic acids which are present in the nuclei of living cells.

Some bacteria use pyrimidines to manufacture *folic* acid, a vitamin necessary for their existence. The pyrimidine ring is found in the sulfa drug, *sulfadiazine*. When bacteria are exposed to this drug, they will take it into their bodies. Since they cannot use pyrimidine in this form they die because normal metabolism is prevented. *J. R. S.*

SEE ALSO: NUCLEOPROTEIN

Iron pyrite crystals are usually cubic

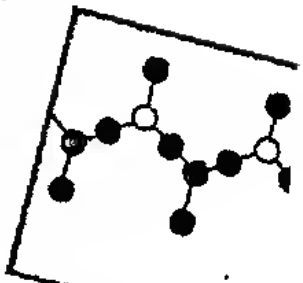
Pyrite (PYE-rite) Pyrite, or iron pyrites, as it is commonly called, is a mineral found throughout the world. Because of its glinting, brassy-yellowish appearance, it has many times been mistaken for gold, and is sometimes called "fool's gold."

The name pyrite is derived from the Greek word meaning "fire" because of the sparks which occur when it is struck with steel. Pyrite will also sustain fire, due to its sulfur content.

Pyrite is the commonest of the sulfide minerals. It is found associated with other sulfides, with oxides, and in quartz veins, in sedimentary and metamorphic rocks, in coal beds. It is also a replacement mineral found in fossils.

In some countries, where sulfur is not common, pyrite is used to obtain pure sulfur, but in the United States it is used commercially mainly for sulfuric acid. The formula for pyrite is FeS_2. *V. V. N.*

Pyroxene (pye-RAHK-seen) A scientist selected the name pyroxene from the Greek, *pyr* meaning "fire" and *xenos*, "stranger;" thus the name



Pyroxenes are a group of compounds of silica (SiO_2)

means "stranger to fire characteristic, however, ious pyroxenes are typic of the igneous or melted

Pyroxene belongs to a gro which show a cleavage angle to 93 degrees parallel to the prism. Chemically the pyroxen *silicates.*

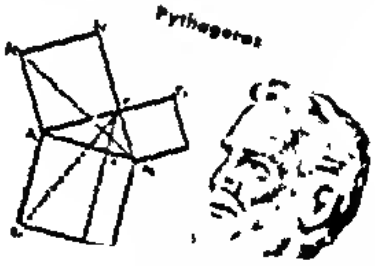
Pyroxene crystals are gene stout, complex prisms. They a in the more basic igneous rocks, developed in the earth by pressure erate heat, as in *gneisses*, sc *marble.*

Pythagoras (pih-THAGG-u (582?-500?) Pythagoras was a philosopher who was active abo B.C. Scarcely anything is known thagoras' early life, but it is be that he was born on the islan Samos.

He was important for having worke a method of proving what is now know the *Pythagorean theorem.* This theo states that the square of the hypotenuse a right-angled triangle is equal to the s of the squares of the other two sides. *D. H.*

SEE ALSO: GEOMETRY

Python see Snakes



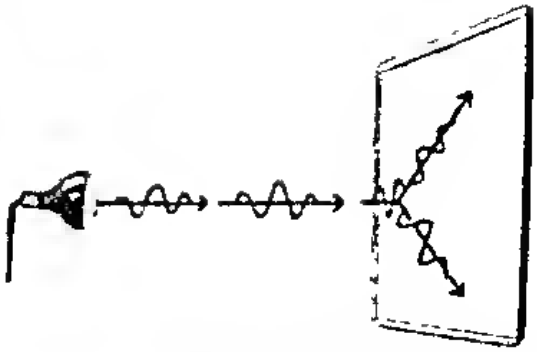
Pythagoras

Quadruplets see Multiple births

Quail There are several types of quail known as mountain quail, valley quail, and Virginia partridge. Perhaps the most familiar name for quail is *bob-white*, a name the quail has earned because of the sound of its song. This song is heard most often before rain. Many people say the quail forecasts rain and is singing, "more wet, more wet."

Quail are the size of plump robins. Their striped and mottled brown, black and white coloring is protective. They spend their lives in fields and farmlands searching for food of weed seeds and insects. They fly only on short flights and then only if suddenly frightened. About eighteen eggs are laid in ground nests. After twenty-four days, the fully-feathered babies hatch and immediately run about looking for food. Quail are sociable birds and always live together in groups called *coveys*. They sleep huddled in circles but always with heads pointed outward. Any unusual sound scatters them in all directions. Heavy snows and hunters are their enemies. Hunting this valuable game bird is restricted in most areas. J. A. D.

Quantum theory (KWAHN-tuhm) In 1900 Max Planck, professor of theoretical physics in Berlin, found a mathematical formula that described the energy of a radiating substance. He found that the transfer of energy was not continuous, but instead in- : little packets, or bundles, called . (The rainbow which appears a continuous band of color is ly made up of little units, or dles, of light of different energies.)

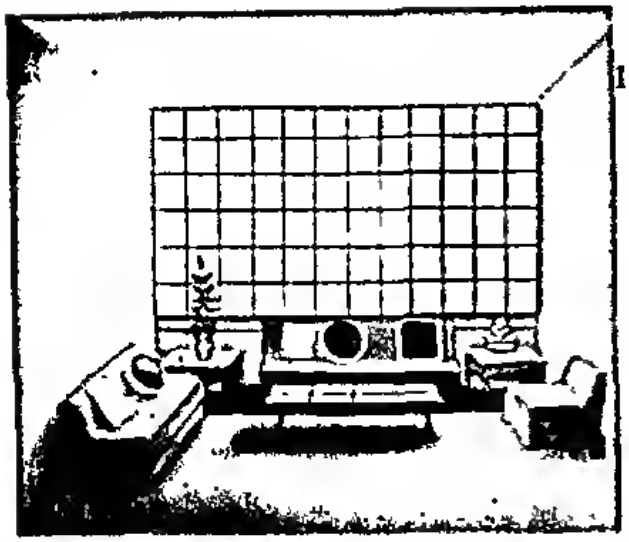


When a photon collides with an electron at the surface of a substance, the electron is excited into motion. This results in heat or electric current being produced, or a change in conductivity of the surface material, depending on the nature of the substance

When any piece of matter is heated, it starts to glow, gets red hot, and white hot at higher temperatures. This excitement of atoms, or molecules, of the matter is called *radiation*. When black materials are heated, the radiation depends solely upon the temperature. With colored materials, radiation is dependent upon more factors than temperature. Therefore, the radiation emitted by a black material at high temperatures is a suitable object for research because there is only the factor of temperature to consider. The radiation of a black body should be explainable in terms of the laws for radiation and heat. In the late 1800's Lord Rayleigh and Sir James Jeans attempted to explain this hypothesis, but they failed.

When Planck attacked this problem, he turned from black-body radiation to radiating atoms. Experimental data on heat and light-radiating atoms led him to devise a mathematical formula to account for the behavior of such radiation energy. Surprisingly, his formula made it seem that atoms contain only *discrete* quantities, or quanta (*quantum* is the singular form) of energy, rather than their possessing continuous wave-like energy as classical physics had always assumed. The formula produced a puzzle such as one would face if a car can travel at 50 and at 52 miles per hour, but cannot go at 51 m.p.h.

In 1905, ALBERT EINSTEIN gave theoretical support for Planck's observations. Einstein's explanation was based on an experiment, the *photoelectric effect*, which showed that the energy of electrons emitted when light fell on a metallic surface depended, not



In this electroluminescent wall, an electric current frees electrons, which strike atoms of the phosphor which then emit photons (bundles of light energy)

upon how much light was present, but rather upon the frequency (or wave length) of the light. That is, the size of the radiation units called *photons* (quantum units) depended upon the rate of vibration of the atoms of the particular material; furthermore, the total energy emitted was related only to this rate, and thus could be expressed mathematically by merely three symbols, one of which was the "constant of proportionality." In honor of Max Planck, this constant was called *Planck's Constant*. The formula is: $E = Hf$, where E stands for the total energy of the emitted photon (in erg-seconds); f is the rate at which the radiant energy is vibrating, and H is Planck's Constant. (H is calculated to be 6.62×10^{-27}.)

In other words, Planck and Einstein stated that light (and other radiant energy) travels through space, in continuous waves, but is absorbed or emitted in energy packets, or quanta.

Shortly after the quantum theory was first announced, Niels Bohr, a Danish physicist, was able to apply it further to form a new theory about atomic structure. Bohr's original atomic model has been modified, but even the latest theories still agree with the idea of energy quanta. J. B. S.

SEE ALSO: LIGHT, PHOTON, RADIATION

Quarantine Quarantine is the isolation of persons, animals, or plants which have been exposed to communicable diseases. The quarantine period lasts for a time equal to the incubation period of the disease.

Quarry (KWAWR-ee) A quarry is an opening in the earth caused by removal of stone. Such rocks as limestone, marble, sandstone, and granite are obtained by the procedure known as *quarrying*.

Quarrying is accomplished by the methods of *explosion*, "*plug and feather*," and *channeling*. Explosion is done with dynamite or gunpowder to open or clear large areas. The resulting rubble is of primary use for roads or for smelting limestone rock.

The other methods are used chiefly for quarrying building stone. Plug and feather refers to a wedge with two half cylindrical pieces fitting on either side which are placed in a series of drilled holes in rock. Hammering the wedge spreads the "feathers" to apply pressure, causing a splitting of the formation.

Channeling involves a locomotive-like vehicle on a track with mechanical chisels to channel or cut the rock. This represents modern mechanized quarrying. D. J. I.

Quarrying granite

Quartz Quartz is one of the most common minerals. It consists of *silicon dioxide*, or *silica*. It is found in many places and in many types of rock formations. Several varieties of quartz are used as gems. Others are building materials. Quartz is very hard.

There are many colors and many varieties of quartz. The color is due to other minerals and determines certain varieties. *Rock crystal* is pure, clear, transparent quartz. Purple quartz is called *amethyst*. These are crystalline varieties. *Agate* is an opaque type in which the color is distributed unevenly

J. Daniel Williams

ROCK CRYSTAL QUARTZ IN NATURAL STATE

AMETHYST

CITRINE

QUARTZ IS A HEXAGONAL CRYSTAL. OTHER MINERALS PRESENT IN THE QUARTZ WILL PRODUCE COLOR, AS SHOWN IN THE POLISHED STONES

ROSE QUARTZ

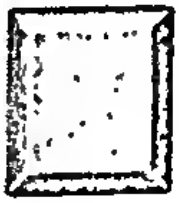
JASPER

CHALCEDONY

OPAL

FLINT

AGATE



CARNELIAN

through its mass. Sometimes the color runs through in curved bands. In *moss agate* specimens, the color is arranged so that it looks as if moss or other vegetable matter has been "frozen" in the quartz. Agate, *carnelian,* and *onyx* are usually considered as special types of quartz—*chalcedony.* Chalcedony is the *massive* form of quartz. Other varieties include bloodstone, flint, jasper, sand and gravel, sandstone, and quartzite. C. L. K.

SEE ALSO: AGATE, AMETHYST, GEM, ONYX

Quartzite see Rocks

Quaternary see Cenozoic Era, Geologic time table

Queen see Ants, Bees

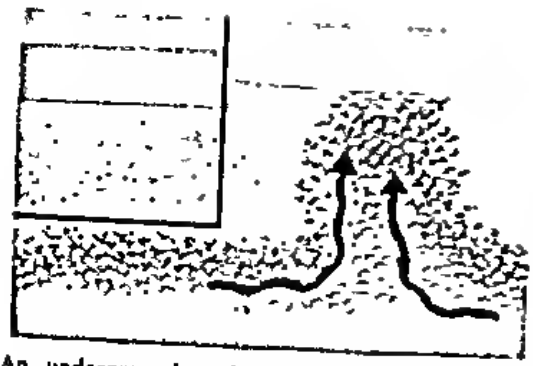
Anne's lace see Wild flowers

Quicklime see Lime

Quicksand Quicksand is a bed of very fine, powdery, wet sand. It may look solid, but it is like a thick fluid. It will not support anything heavy. Men, animals, trains, or automobiles can be swallowed up if they move onto quicksand.

Under quicksand there is usually a layer of clay. The clay keeps the water from draining away from the sand. Quicksand is often found at the mouths of rivers where fine sand has been deposited on clay. It can also be found around lakes or ponds if a hollow pocket in a clay shore holds it and keeps it wet.

Quicksand is very treacherous. There are



An underground spring that does not have enough outlets for the water may keep sand floating loosely. The upper left shows packed sand under still water, or water with outlets

many tales of men sinking into quicksand. A man need not be swallowed up, however. If he remains calm and still and takes special care not to move his feet, he will stop sinking when he is in quicksand up to his armpits. His weight then will balance the weight of displaced sand. C. L. K.

SEE ALSO: GEOLOGY

Quicksilver see Mercury (element)

Quill see Feather

Quince Flowering quinces are popular garden shrubs that are among the first to blossom in the spring. These shrubs belong to the rose family and come from eastern Asia. The five-petaled, showy flowers bloom before or with the unfolding of the leaves. They make fine specimen plants and are also used for hedges. They are easily raised in most soils and are propagated by cuttings or layering.

Japonica is a variety known as dwarf Japanese quince. It is a low, spreading plant that grows about three feet high and has red flowers.

Lagenaria is known as Japanese quince. It grows four to six feet tall and has spiny branches. Its flowers are scarlet or white, but some have pink flowers that turn red in the fall. It is the best flowering quince for hedges.

The hard, acid fruit called quince is related to the pear and apple. It is also a member of the rose family. The fruit is very tasty when it is cooked. M. R. L.

Flowering quince

Quinine (KWY-nyne) Quinine is a fever-reducing drug used in the treatment of MALARIA. It is a white, odorless, crystalline powder with a bitter taste. It comes from the bark of the *cinchona tree* originally found in South America. Because of the demand for quinine, the tree is now raised in the East Indies, Jamaica, Java, and other tropical countries. To prepare quinine, the bark is stripped from the trees and dried. It is then ground into a powder, from which the quinine is extracted.

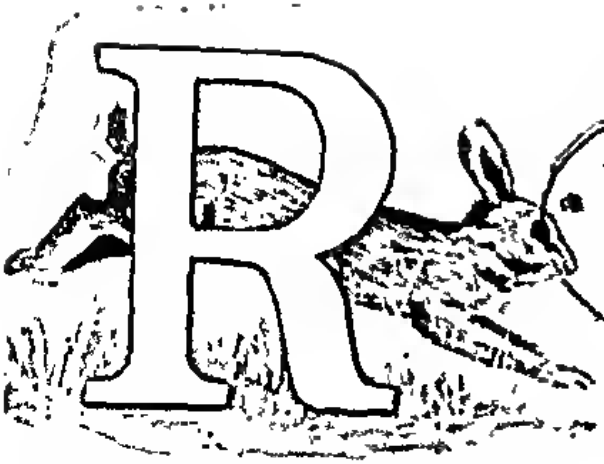
Cinchona bark was used in early times by the Inca Indians of South America, who called it *quinaquina*. It was introduced in Europe in 1640, when it was used to cure the fever of the wife of the Peruvian Viceroy. She was Countess Cinchon, for whom the cinchona tree was named.

Before World War II, most quinine came from the Dutch East Indies When the Dutch East Indies fell into Japanese hands, the supply of quinine for the Allied troops fighting in the tropics was cut off. It was necessary to develop synthetic drugs for the control of malaria, and *atabrine* became the best known.

Quinine is also used as a remedy for joint and muscle pain and for headaches, in the treatment of varicose veins, and as an appetite stimulant. M. R. L.

Quintuplets see Multiple births

Quinine is obtained from the cinchona tree



Courtesy Society For Visual Education, Inc.

Snowshoe rabbit, or varying hare, is a true hare. Its coat or pelage, changes color as the seasons change

Rabbit The rabbit family includes both hares and rabbits. They are small, furry, gnawing mammals with long ears and short tails. They can run fast, taking great leaps with their long, powerful hind legs.

Rabbits and hares are alike, except for size and nesting habits. Rabbits are much smaller than hares. European ones usually have their babies in an underground burrow which they have dug themselves, or which another animal has dug. Their babies are blind and helpless, and have no fur when they are born. American hares rarely dig burrows. They usually have their babies out in the open or in a shady spot under a clump of bushes. Baby hares are well-developed when they are born. They have warm coats of fur, their eyes are open, and they are soon able to care for themselves. *Jack rabbits, arctic hares,* and *varying* or *snowshoe hares* are all true hares. *Cottontails, pygmy rabbits,* and *swamp rabbits* are wild rabbits.

There are several groups of jack rabbits found on the plains of North America. They are big hares about twenty-eight inches long, weighing up to ten pounds. They have very long ears and very long hind legs. They are well-known for their speed. A mother jack rabbit may have as many as six litters each year, with two to four babies in each litter. When jack rabbits become too numerous and start to damage crops in their search for food, they are poisoned until their . are under control. Many rabbits

Courtesy Society For Visual Education, Inc.

Jack rabbit has especially long hind legs

Courtesy Society For Visual Education, Inc.

Cottontail rabbit, common through North America

Pika, a short-eared member of the rabbit family

F. A. Bloomfield
Domestic rabbit, New Zealand white

and hares also die from disease, such as rabbit fever (*tularemia*), which may also be fatal to man, and infectious *myxomatosis*.

Jack rabbits are active in the early morning and late afternoon. They spend the warm part of the day in a shady resting spot called a *form*. Each jack rabbit seems to have its own form.

The varying or snowshoe hare, found in the colder parts of northern North America, is white in winter and brown in summer. It sheds twice a year, growing a coat of brown in the spring and a coat of white in the fall. Its feet, which are long, broad, and heavily furred, serve as snowshoes in winter.

The arctic hare is a large white hare with short ears and legs and snowshoe feet. It feeds on mosses and grasses growing under the arctic snow.

Interesting members of the rabbit family are the *cony* or *pika*, living in colonies above the timberline in mountains in the Northern Hemisphere. They are small, brown animals weighing less than a pound. Their diet is grass and moss, which they store for winter.

The brown cottontail rabbit, common throughout North America, is easily identified by the white underside of its tail, seen as it runs away. It is a small rabbit, weighing about two or three pounds. Cottontails eat tender green plants, usually feeding in the early morning or late afternoon and spending the rest of the day under a bush or some other protective cover. The mother builds the grassy nest in a shallow hole in the ground, lining it with bits of its fur. Several litters of two to six babies may be born during the spring and summer.

Enemies of the cottontail include the fox, coyote, lynx, hawk, and owl, as well as man who hunts it for food.

Marsh or *swamp rabbits* are cottontails found in the swampy areas of southern United States. Their fur is a darker brown and their tails are not as white. The Idaho pygmy rabbit, found on the prairies of California, Nevada, Oregon, and Idaho, looks like a small cottontail with similar habits.

There are also many varieties of domestic rabbits. Some are raised for their meat and fur, and some are raised as pets. D. J. A.

SEE ALSO RODENTIA

Rabbit fever see Animal diseases, Rabbit

Rabies Rabies is a disease found among wild and domestic animals. It is sometimes called *hydrophobia*, which means "fear of water," because rabies causes paralysis of throat muscles, and the victim, although thirsty, cannot swallow.

In *dumb rabies* the infected animal is listless, dull-eyed and unable to swallow. The voice is hoarse, the mouth hangs open and the jaw drips saliva. There is no indication of unfriendliness, and many times the disease is not recognized until infection has passed on through a break in the skin of the animal's handler. *Furious rabies* is easier to recognize because the infected animal, in addition to hoarseness and slobbering, wanders off and becomes violent.

Rabies among wild animals, fox, bats, skunks, and squirrels, is referred to as *sylvatic rabies*. In domestic animals it is known as *urban* rabies. All pets should be given anti-rabies vaccinations for protection of the pet and the owner. Health departments make every effort to curb the disease by vaccinating stray animals, and issuing dog licenses. This dread disease can be transmitted to any unvaccinated pet by wild animals.

The rabies' virus lives in the salivary glands of the infected animal and can be passed on to humans through a bite. The virus travels by nerve trunks to the central nervous system where it finally causes death to the nerve cells. The period between the entry of the rabies' virus into the body and the first signs of the disease may be from four to eight weeks.

For humans exposed to rabies, Pasteur anti-rabies vaccine is administered for a period of 21 days for bites around the head, and fourteen days for bites elsewhere on the body. C. A. D.

SEE ALSO ANIMAL DISEASES, PASTEUR, LOUIS

Courtesy Society For Visual Education, Inc.
North American raccoon

Raccoon Raccoons, or "coons," are small stout animals with long grayish-black fur and bushy black-ringed tails. Patches of black fur around their eyes make them look as if they are wearing masks. Full-grown raccoons are about thirty-two inches long and weigh about twenty pounds. These flesh-eating (*carnivorous*) mammals are closely related to the bear. Their long legs, grasping feet, and strong claws make them excellent climbers.

Raccoons may be found throughout most of North and Central America. These curious little animals are nocturnal, usually sleeping during the day, and hunting at night. They eat fish, frogs, crayfish, and mussels which they catch in the shallow water along the edges of ponds and streams. They also eat fruit, berries, nuts, honey, corn and hunt birds, mice, reptiles, insects, and occasionally poultry. When water is available, they will carefully wash their food before eating.

Baby raccoons are born in late spring, either in a hollow tree, in a crevice among some rocks, or in a burrow in the ground.

Raccoons are hunted for their fur which is made into coats and coonskin caps in which the long bushy tail is used as a tasset. Raccoons are hunted at night with the help of dogs. Raccoons are courageous fighters. If captured young, these intelligent little animals are easily tamed and may be kept as pets. D. J. A.

Race Race is a *subdivision* of a species. It is made up of animals or plants, usually of one locality, having a combination of physical characteristics, such as appearance or bodily structure, which distinguishes them from others of the species. These characteristics can be inherited.

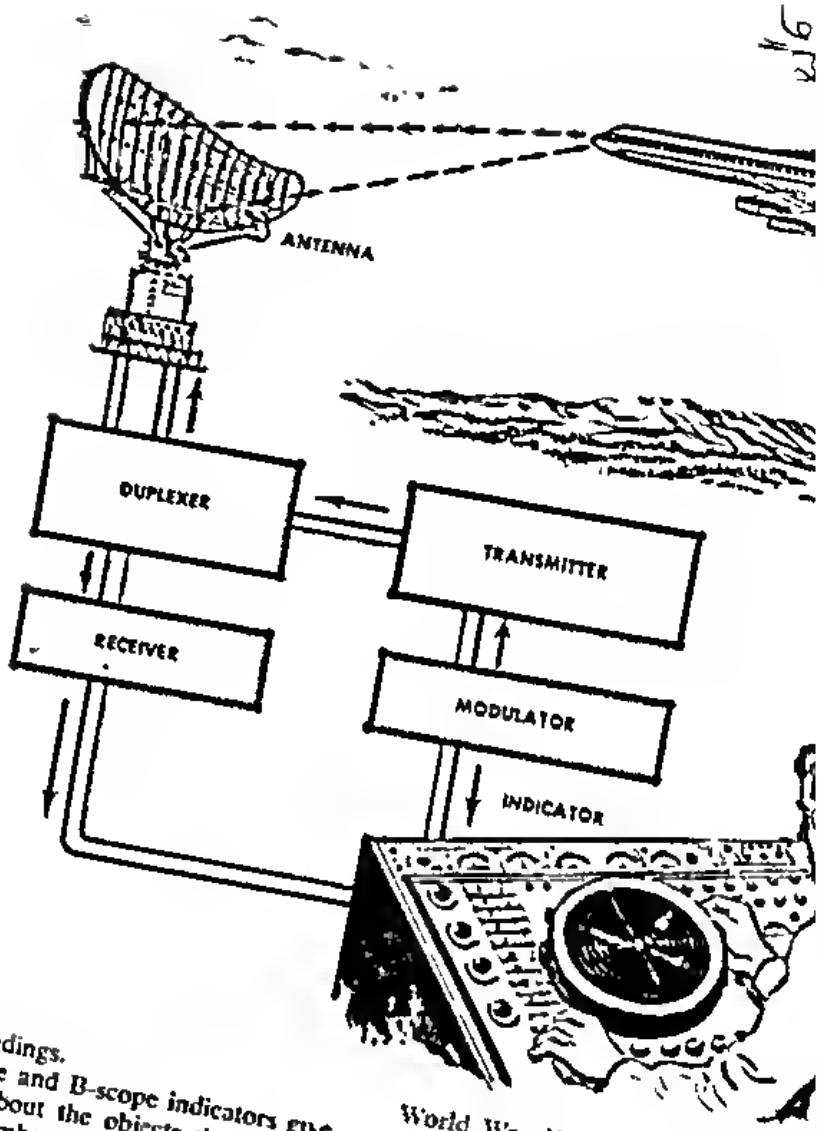
Radar Radar is an electronic system that permits man to see objects at great distances regardless of darkness or bad weather. It is used to direct both air and sea traffic, and for detection and identification of unknown ships and aircraft.

Sound waves bouncing off hillsides or tunnel walls create an echo. Radar works in the same way by sending out short *pulses* of radio energy which bounce off objects in their path and return to the sender as a type of echo. The reflected impulses are shown on a screen, like that of a television set, as spots of light, or *blips*.

Most radar sets have six important parts; the *modulator*, which turns the transmitter on to send a pulse and off to receive an echo; the *transmitter*, which sends the very short, or *microwave*, pulses; the *antenna*, which focuses the pulses into a narrow beam and also receives the echoing signals; the *duplexer*, which, as a switching device, connects first the transmitter and then the receiver to the antenna; the *receiver*, which is a listening and amplifying device to strengthen weak echoes so that they will show on the radar screen; and the *indicator*, which displays the blips to the operator on its screen.

KINDS OF INDICATORS

While most radar sets work in the same way, there are several types of indicators, each designed for a particular job. The *Plan Position Indicator*, or PPI, is the most common type. It has a round screen with a compass scale around the outside. On this screen a beam of light, representing the beam of radar pulses being sent out of the antenna, rotates like the second hand of a clock. As this beam, or *trace*, sweeps around the screen, the blips appear as spots of light when it passes. The distance of the objects they represent is determined by their distance on the screen from the center, which is the station. The screen usually has rings showing distance from the center. Another type of indicator is the *Range Height Indicator*, or RHI, which measures the height of objects such as airplanes. The RHI has a trace that sweeps up and down and shows the range and height of an object in one given direction. It is used to assist pilots in



instrument landings.

The A-scope and B-scope indicators give more details about the objects they detect, such as the number of aircraft in a formation.

SPECIAL USES OF RADAR

Police forces use *Doppler*, or *Continuous Wave*, radar to determine the speed of passing automobiles. This type of radar sends out continuous radio waves instead of pulses. The rate of vibrations, or frequency, of the returning echoes is different from the frequency of the transmitted signal, and this difference is measured to obtain the speed of the target.

The first radar that measured distance and direction was developed in 1934 by a U. S. Navy scientist, R. M. Page. Radar was used widely by the Allies and their enemies in World War II, and following the w given many civilian applications. Tod used in weather forecasting, in navi and in helping to prevent collisions be both ships and airplanes.

SEE ALSO: INSTRUMENT LANDING SYS

Radial symmetry see Animals, cl fication of

Radiant energy Radiant energy ENERGY which travels in the form electromagnetic waves. These wav are classified in order of decreasin wave length *as radiowaves, infrare waves, visible light, ultraviolet rays, X-rays,* and *gamma-rays.*

SEE: RADIATION

GALILEO GALILEI
1564–1642 •
Discovered law of pendulum motion

CAROLUS LINNAEUS
• 1707–1778
Classified the plant and animal kingdoms

SIGMUND FREUD
• 1856–1939
Started psychoanalysis

GREGOR JOHANN MENDEL
1822–1884 •
Discovered principles of heredity

BARON ERNEST RUTHERFORD
1871–1937 •
Contributed to knowledge of radioactivity and atomic structure

GUGLIELMO MARCONI
• 1874–1937
Invented the wireless telegraph

LOUIS AGASSIZ
• 1807–1873
Investigated glacial moves and marine life

MICHAEL FARADAY
1791–1867 •
Discovered electromagnetic induction

SIR ISAAC NEWTON
• 1642–1727
Discovered laws of light gravity, motion and color

ALBERT EINSTEIN
1879–1955 •
Conceived the Theory of Relativity

WILHELM RONTGEN
• 1845–1923
Discovered X-rays

JOSEPH LISTER
• 1827–1912
Started antiseptic surgery

ALEXANDER GRAHAM BELL
1847–1922 •
Invented the telephone